



①9 BUNDESREPUBLIK
DEUTSCHLAND



DEUTSCHES
PATENT- UND
MARKENAMT.

⑫ **Offenlegungsschrift**
⑩ **DE 198 01 803 A 1**

⑤1 Int. Cl.⁶:
H 02 K 19/26
H 02 K 19/38

②1 Aktenzeichen: 198 01 803.7
②2 Anmeldetag: 19. 1. 98
④3 Offenlegungstag: 29. 4. 99

DE 198 01 803 A 1

Mit Einverständnis des Anmelders offengelegte Anmeldung gemäß § 31 Abs. 2 Ziffer 1 PatG

⑦1 Anmelder:
Siemens AG, 80333 München, DE

⑦2 Erfinder:
John, Helmut, Dipl.-Ing. (FH), 99189 Elxleben, DE

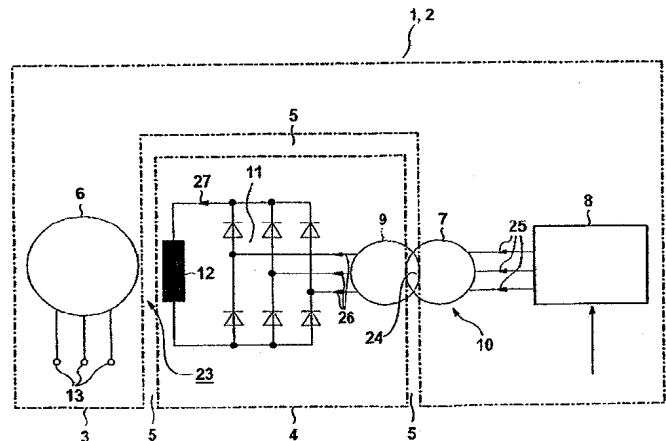
⑤6 Entgegenhaltungen:
DE 33 20 644 A1
CH 4 65 050
Ryff, Peter F.: "Electrical Machines and Transformers", Englewood Cliff, N.J. 07632, 1987, S.163;
Reuttsch, H.: "Elektromotoren- Electric Motors", Turgl, CH, 1992, S. 508;
Heier, Siegfried: "Windkraftanlagen im Netzbetrieb" Stuttgart, 1996, S. 125-127;

Die folgenden Angaben sind den vom Anmelder eingereichten Unterlagen entnommen

Prüfungsantrag gem. § 44 PatG ist gestellt

⑤4 Elektrische Rotationsmaschine und Verfahren zur Übertragung elektrischer Leistung

⑤7 Die Erfindung betrifft eine elektrische Rotationsmaschine mit einem feststehenden Stator und einem drehbaren Rotor. Der Stator und der Rotor weisen dabei eine Statortransformatorwicklung bzw. eine Rotortransformatorwicklung auf, wobei die Transformatorwicklungen einen elektrischen Transformator bilden und jeweils für einen Betrieb mit Wechselstrom ausgeführt sind. Die Erfindung betrifft weiterhin ein Verfahren zur Übertragung elektrischer Leistung von einem feststehenden Stator auf einen drehbaren Rotor.



DE 198 01 803 A 1

Die Erfindung betrifft eine elektrische Rotationsmaschine mit einem Rotor und einem Stator, die insbesondere als Wechselstromgenerator ausgeführt ist. Die Erfindung betrifft weiterhin ein Verfahren zur Übertragung elektrischer Leistung von einem feststehenden Stator auf einen drehbaren Rotor, insbesondere zur Erregung eines Wechselstromgenerators.

Zum Betrieb einer elektrischen Rotationsmaschine mit einem Rotor und einem Stator wird eine zur elektrischen Rotationsmaschine zugehörige Erregerwicklung mit einem Erregergleichstrom beaufschlagt. Ist die Erregerwicklung im Rotor angebracht, muß der Erregergleichstrom vom feststehenden Stator zum rotierenden Rotor übertragen werden. Aus Ryff, Peter F., "Electrical machines and transformers", Englewood Cliffs, N.J. 07632, 1987, Seite 163 sowie Rentzsch, H., "Elektromotoren - Electric Motors", Turgli, Schweiz, 1992, Seite 508, ist es bekannt, daß der Rotor zu diesem Zweck Schleifringe aufweist, die mit feststehenden dem Stator zugehörigen Kontaktbürsten kontaktiert werden, wodurch der Erregerstrom über die Kontaktbürsten auf die Schleifringe übertragen wird.

Aus Ryff, Peter F., "Electrical machines and transformers", Englewood Cliffs, N.J. 07632, 1987, Seite 163 und Rentzsch, H., "Elektromotoren - Electric Motors", Turgli, Schweiz, 1992, Seite 508 sowie aus Heier, Siegfried, "Windkraftanlagen im Netzbetrieb", Stuttgart, 1996, Seite 125-127 ist es bekannt, den Erregerstrom in einer zur elektrischen Rotationsmaschine zugehörigen Erregermaschine zu erzeugen, was auch unter der Bezeichnung "bürstenlose Erregung" bekannt ist. Die Erregermaschine weist eine Wechselstromwicklung und eine Außenpolwicklung auf, die jeweils mit dem Rotor bzw. Stator verbunden sind. Die Wechselstromwicklung und die Außenpolwicklung sind dabei so ausgeführt, daß bei einer Beaufschlagung der Außenpolwicklung mit einem Gleichstrom, ein Magnetfeld erzeugt wird, das bei einer Drehung des Rotors in der Wechselstromwicklung einen Wechselstrom induziert. Der Wechselstrom wird einem zum Rotor zugehörigen Gleichrichter zugeführt. In dem Gleichrichter wird der Wechselstrom gleichgerichtet und als Erregerstrom der Erregerwicklung zugeführt.

Aufgabe der Erfindung ist es, eine elektrische Rotationsmaschine mit einer modifizierten Erregung anzugeben. Eine weitere Aufgabe ist es, ein Verfahren zur Übertragung elektrischer Leistung von einem feststehenden Stator auf einen drehbaren Rotor anzugeben.

Die Erfindung geht hierbei von der Erkenntnis aus, daß sowohl für eine korrekte Funktionsweise der Übertragung des Erregerstroms über Kontaktbürsten und Schleifringe, als auch für eine Induktion eines Wechselstroms in der Wechselstromwicklung der Erregermaschine mit einer zur Erregung notwendigen Stärke, eine Drehung des Rotors mit einer Mindest-Drehfrequenz oder Mindest-Drehzahl erforderlich ist. Bei elektrischen Rotationsmaschinen, die als Wechselstromgenerator, insbesondere als Windkraftgenerator ausgeführt sind, kann die Forderung nach einer Mindest-Drehfrequenz bei den bekannten Erregeranordnungen nicht immer eingehalten werden.

Erfindungsgemäß wird die auf die elektrische Rotationsmaschine gerichtete Aufgabe gelöst durch eine elektrische Rotationsmaschine mit einem Stator und einem Rotor, wobei der Stator eine Statortransformatorwicklung und der Rotor eine Rotortransformatorwicklung aufweisen, welche Transformatorwicklungen einen elektrischen Transformator bilden und für einen Betrieb mit Wechselstrom ausgeführt sind.

Für einen Betrieb mit Wechselstrom weisen die Transformatorwicklungen Pole auf, die z. B. aus geschichteten, gegeneinander elektrisch isolierten, magnetisierbaren Blechen ausgebildet sind. Wird die Statortransformatorwicklung mit einem elektrischen Wechselstrom beaufschlagt, wird dieser Wechselstrom in die Rotortransformatorwicklung transformiert und zu einer Erregung der elektrischen Rotationsmaschine verwendet. Dies ist insbesondere bei einer niedrigen Drehfrequenz des Rotors, wie sie bei einem Betrieb einer als Windkraftgenerator ausgebildeten elektrischen Rotationsmaschine auftreten kann, vorteilhaft, weil zur Transformation des Wechselstroms keine Drehung des Rotors erforderlich ist. Der auf den Rotor transformierte Wechselstrom kann für die zum Betrieb des Windkraftgenerators notwendige Erregung, insbesondere bei niedrigen Drehzahlen oder stillstehendem Rotor, verwendet werden. Eine Steuerung oder Regelung der Stärke des Wechselstroms kann schaltungstechnisch einfach erfolgen.

Bevorzugtermaßen ist die elektrische Rotationsmaschine so ausgeführt, daß sie mit einer Drehfrequenz des Rotors zwischen 0,01 Hz und 500 Hz betreibbar ist.

Bevorzugtermaßen wird beim Betrieb der elektrischen Rotationsmaschine durch den Transformator ein Wechselstrom mit einer Frequenz transformiert, welche Frequenz größer ist, als die Drehfrequenz. Dadurch ist eine Beeinflussung der Transformation des Wechselstroms durch die Drehung des Rotors vernachlässigbar. Der Wechselstrom wird hierbei mit der Differenzfrequenz von der Frequenz zur Drehfrequenz transformiert.

In einer weiter bevorzugten Ausgestaltung der elektrischen Rotationsmaschine, ist die Statortransformatorwicklung elektrisch mit einer Wechselstromquelle, insbesondere einem Versorgungsnetz eines elektrischen Energieversorgungsunternehmens verbunden. Der Wechselstrom, mit dem die Statortransformatorwicklung beaufschlagt wird, wird dabei von der Wechsel-Stromquelle geliefert.

Bevorzugtermaßen weist der Stator eine Generatorwicklung und der Rotor eine Erregerwicklung auf, wodurch ein Wechselstromgenerator, insbesondere ein Drehstromgenerator gebildet ist. Weiter bevorzugt weist der Rotor einen Gleichrichter auf, wobei die Erregerwicklung elektrisch über den Gleichrichter mit der Rotortransformatorwicklung verbunden ist. Der über den elektrischen Transformator transformierte Wechselstrom, wird von der Rotortransformatorwicklung abgegeben und nach einer Gleichrichtung durch den Gleichrichter als Erregerstrom der Erregerwicklung zugeführt. Der Erregerstrom in der Erregerwicklung erzeugt ein Magnetfeld, welches bei einer Drehung des Rotors in der Generatorwicklung einen Generatorwechselstrom induziert, welcher einem elektrischen Verbraucher zuleitbar ist.

Vorzugsweise gibt die als Wechselstromgenerator ausgebildete elektrische Rotationsmaschine im Betrieb eine elektrische Leistung zwischen 1 W und 1 GW ab, welche abhängig von der Drehfrequenz des Rotors sein kann.

Die elektrische Rotationsmaschine ist vorzugsweise als Windkraftgenerator ausgeführt. Sie ist bevorzugtermaßen in einer Windkraftanlage angeordnet, wobei der Rotor mit einer drehbaren Welle verbunden ist, welche Welle ein Flügelrad mit zumindest einem Flügel aufweist. Der Rotor kann dabei beispielsweise über ein Getriebe oder getriebeles mit der Welle verbunden sein. Es ist ebenfalls möglich, daß die Welle selbst den Rotor bildet. Das dem Wind ausgesetzte Flügelrad bewirkt die zur Generierung des Generatorwechselstroms erforderliche Drehung der Welle.

Die auf das Verfahren zur Übertragung elektrischer Leistung gerichtete Aufgabe wird erfindungsgemäß dadurch gelöst, daß elektrische Leistung transformatorisch über ei-

nen Luftspalt von einem feststehenden Stator auf einen drehbaren Rotor übertragen wird. Insbesondere bei einem Rotor, der sich mit einer sehr geringen Drehfrequenz dreht, kann hierdurch einfach eine elektrische Leistung übertragen werden, die bevorzugtermaßen einer Erregerwicklung eines Generators, insbesondere eines Windkraftgenerators zugeführt wird, wodurch die Erregerwicklung erregt wird. Bei dem Verfahren wird ein elektrischer Wechselstrom transformiert.

Anhand des in der Zeichnung dargestellten Ausführungsbeispiels werden die elektrische Rotationsmaschine und das Verfahren zur Übertragung elektrischer Leistung über einen Luftspalt näher erläutert. Es zeigen schematisiert und teilweise nicht maßstäblich unter Darstellung der für die Erläuterung verwendeten konstruktiven und funktionellen Merkmale:

Fig. 1 ein Schaltbild einer als Drehstromgenerator ausgeführten elektrischen Rotationsmaschine und

Fig. 2 eine als Windkraftgenerator ausgeführte elektrische Rotationsmaschine in einer Windkraftanlage.

Die Bezugszeichen sämtlicher Figuren haben jeweils die gleiche Bedeutung.

Fig. 1 zeigt ein Schaltbild einer elektrischen Rotationsmaschine **1**, die als Wechselstromgenerator, speziell als Drehstromgenerator **2** ausgeführt ist. Das Schaltbild zeigt zwei Schaltungsteile **3** und **4**, die jeweils einem nicht näher dargestellten Stator bzw. Rotor zugehörig sind und im folgenden als Stator **3** bzw. Rotor **4** bezeichnet werden. Der Stator **3** und der Rotor **4** sind durch einen Luftspalt **5** voneinander getrennt. Der Stator **3** weist eine Drehstromgeneratorwicklung **6** und eine Statortransformatorwicklung **7**, die für einen Drehstrombetrieb ausgeführt ist, auf. Der Rotor **4** weist eine Rotortransformatorwicklung **9** auf, die ebenfalls für einen Drehstrombetrieb ausgeführt ist und über einen Drehstromgleichrichter **11** mit einer Erregerwicklung **12** elektrisch verbunden ist. Die Drehstromgeneratorwicklung **6** und die Erregerwicklung **12** bilden einen Drehstromgenerator **23**. Die Statortransformatorwicklung **7** und die Rotortransformatorwicklung **9** bilden einen Drehstromtransformator **10**. Die Statortransformatorwicklung **7** ist an ein nicht näher dargestelltes elektrisches Versorgungsnetz **8** angeschlossen.

Das elektrische Versorgungsnetz **8** gibt einen Primärdrehstrom **25** an die Statortransformatorwicklung **7** ab. Der Primärdrehstrom **25** wird von der Statortransformatorwicklung **7** in die Rotortransformatorwicklung **9** transformiert und von dieser als Sekundärdrehstrom **26** an den Gleichrichter **11** abgegeben. Durch den Gleichrichter **11** wird der Sekundärdrehstrom **26** zu einem Erregerstrom **27** gleichgerichtet und der Erregerstrom **27** in der Erregerwicklung **12** bewirkt die Ausbildung eines nicht näher dargestellten Erregermagnetfeldes. Bei einer Drehung des Rotors **4** wird durch das Erregermagnetfeld in der Drehstromgeneratorwicklung **6** ein Drehstrom induziert, der an Klemmen **13** der Drehstromgeneratorwicklung **6** abgegriffen wird. Auch bei einem stehenden Rotor **4** wird der Primärdrehstrom **25** über den Drehstromtransformator **10** in den Sekundärdrehstrom **26** transformiert. Dadurch ist unabhängig von einer Drehfrequenz des Rotors **4**, insbesondere bei sehr niedrigen Drehzahlen, eine Erregung gewährleistet. Ein Drehstrom wird somit auch bei sehr niedrigen Drehzahlen in der Drehstromgeneratorwicklung **6** induziert, welcher einem nicht dargestellten Verbraucher zugeführt werden kann.

Das Verfahren zur Übertragung elektrischer Leistung über einen Luftspalt wird anhand der **Fig. 1** erläutert. Durch den Drehstromtransformator **10**, welcher aus der dem Stator **3** zugehörigen Statortransformatorwicklung **7** und der dem

Rotor **4** zugehörigen Rotortransformatorwicklung **9** gebildet wird, wobei der Stator **3** und der Rotor **4** voneinander durch den Luftspalt **5** beabstandet sind, wird der Primärdrehstrom **25** in den Sekundärdrehstrom **26** transformiert und somit elektrische Leistung über den Luftspalt **5** übertragen. Weiterhin wird zur Erregung des Drehstromgenerators **2** der Sekundärdrehstrom **26** nach einer Gleichrichtung mit dem Gleichrichter **11** als Erregerstrom **27** der Erregerwicklung **12** zugeführt.

In **Fig. 2** ist eine Windkraftanlage **14** dargestellt. Die Windkraftanlage **14** weist einen Windkraftgenerator **19** auf, der auf einen Mast **20** angeordnet ist. Der Windkraftgenerator **19** umfaßt den Stator **3** und den Rotor **4**. Der Rotor **4** ist über eine Verbindung **28** mit einer drehbaren Welle **17** verbunden, die ein Flügelrad **18** aufweist. Der Stator **3** weist die Drehstromgeneratorwicklung **6** und die Statortransformatorwicklung **7** auf. Dem Rotor **4** zugehörig ist die Rotortransformatorwicklung **9**, die elektrisch über den Gleichrichter **11** mit der Erregerwicklung **12** verbunden ist. Die Statortransformatorwicklung **7** und die Rotortransformatorwicklung **9** bilden den Drehstromtransformator **10** und die Drehstromgeneratorwicklung **6** und die Erregerwicklung **12** bilden den Drehstromgenerator **23**.

Die Statortransformatorwicklung **7** ist elektrisch verbunden mit einer am Boden **21** des Mastes **20** befindlichen Wechselstromquelle **8**. Eine Zuführung eines Erregerstroms zur Erregung der Erregerwicklung **12**, erfolgt auf die gleiche Weise, wie anhand der **Fig. 1** erläutert, wobei der Primärdrehstrom **25** von der Wechselstromquelle **8** an die Statortransformatorwicklung **7** abgegeben wird.

Durch Einwirkung einer Windströmung **22** auf das Flügelrad **18** wird die Welle **17** gedreht, wodurch der Rotor **4** in Drehung versetzt wird. Ein durch die Erregung vorhandenes Magnetfeld, welches nicht näher dargestellt ist, induziert dabei in der Drehstromgeneratorwicklung **6** einen Drehstrom, welcher an den Klemmen **13** abgegriffen wird.

Patentansprüche

1. Elektrische Rotationsmaschine (1) mit einem Stator (3) und einem Rotor (4), wobei der Stator (3) eine Statortransformatorwicklung (7) und der Rotor (4) eine Rotortransformatorwicklung (9) aufweisen, welche Transformatorwicklungen (3,4) einen elektrischen Transformator (10) bilden und für einen Betrieb mit Wechselstrom ausgeführt sind.
2. Elektrische Rotationsmaschine (1) nach Anspruch 1, die mit einer Drehfrequenz des Rotors (4) zwischen 0,01 Hz und 500 Hz betreibbar ist.
3. Elektrische Rotationsmaschine (1) nach Anspruch 2, bei der im Betrieb ein Wechselstrom mit einer Frequenz durch den Transformator (10) transformiert wird, wobei die Frequenz größer ist, als die Drehfrequenz.
4. Elektrische Rotationsmaschine (1) nach einem der vorhergehenden Ansprüche, wobei die Statortransformatorwicklung (7) elektrisch mit einer Wechselstromquelle (8) verbunden ist.
5. Elektrische Rotationsmaschine (1) nach einem der vorhergehenden Ansprüche, wobei der Stator (3) eine Generatorwicklung (6) und der Rotor (4) eine Erregerwicklung (12) aufweisen, wodurch ein Wechselstromgenerator, insbesondere ein Drehstromgenerator (23), gebildet ist.
6. Elektrische Rotationsmaschine (1) nach Anspruch 5, wobei die Erregerwicklung (12) elektrisch über einen Gleichrichter (11) mit der Rotortransformatorwicklung (9) verbunden ist.

7. Elektrische Rotationsmaschine (1) nach Anspruch 5 oder 6, die im Betrieb eine elektrische Leistung zwischen 1 W und 1 GW abgibt.

8. Elektrische Rotationsmaschine (1) nach Anspruch 5, 6 oder 7, die als Windkraftgenerator ausgeführt ist. 5

9. Elektrische Rotationsmaschine (1) nach Anspruch 8, die in einer Windkraftanlage (14) angeordnet ist, wobei der Rotor (4) mit einer drehbaren Welle (17) verbunden ist, welche Welle (17) ein Flügelrad (18) mit zumindest einem Flügel aufweist 10

10. Verfahren zur Übertragung elektrischer Leistung, bei dem elektrische Leistung transformatorisch über einen Luftspalt (5) zwischen einer Statortransformatorwicklung (7) eines feststehenden Stators (3) und einer Rotortransformatorwicklung (9) eines drehbaren Rotors (4) übertragen wird. 15

11. Verfahren nach Anspruch 10, wobei die elektrische Leistung über die Rotortransformatorwicklung (9) einer Erregerwicklung (12) des Rotors (4) eines Wechselstromgenerators (23), insbesondere eines Windkraftgenerators (19), zugeführt und dadurch die Erregerwicklung, (12) erregt wird. 20

Hierzu 2 Seite(n) Zeichnungen

25

30

35

40

45

50

55

60

65

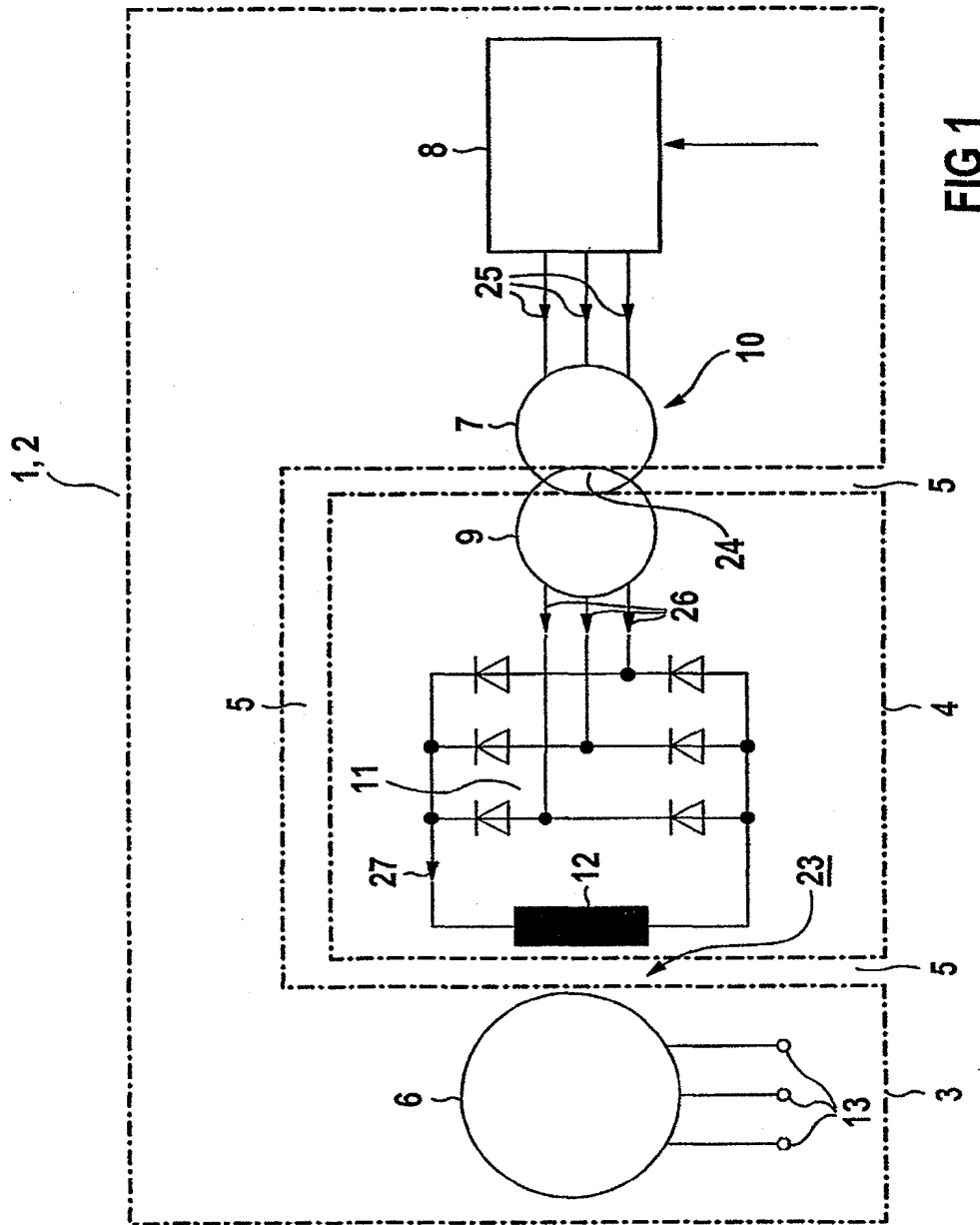


FIG 1

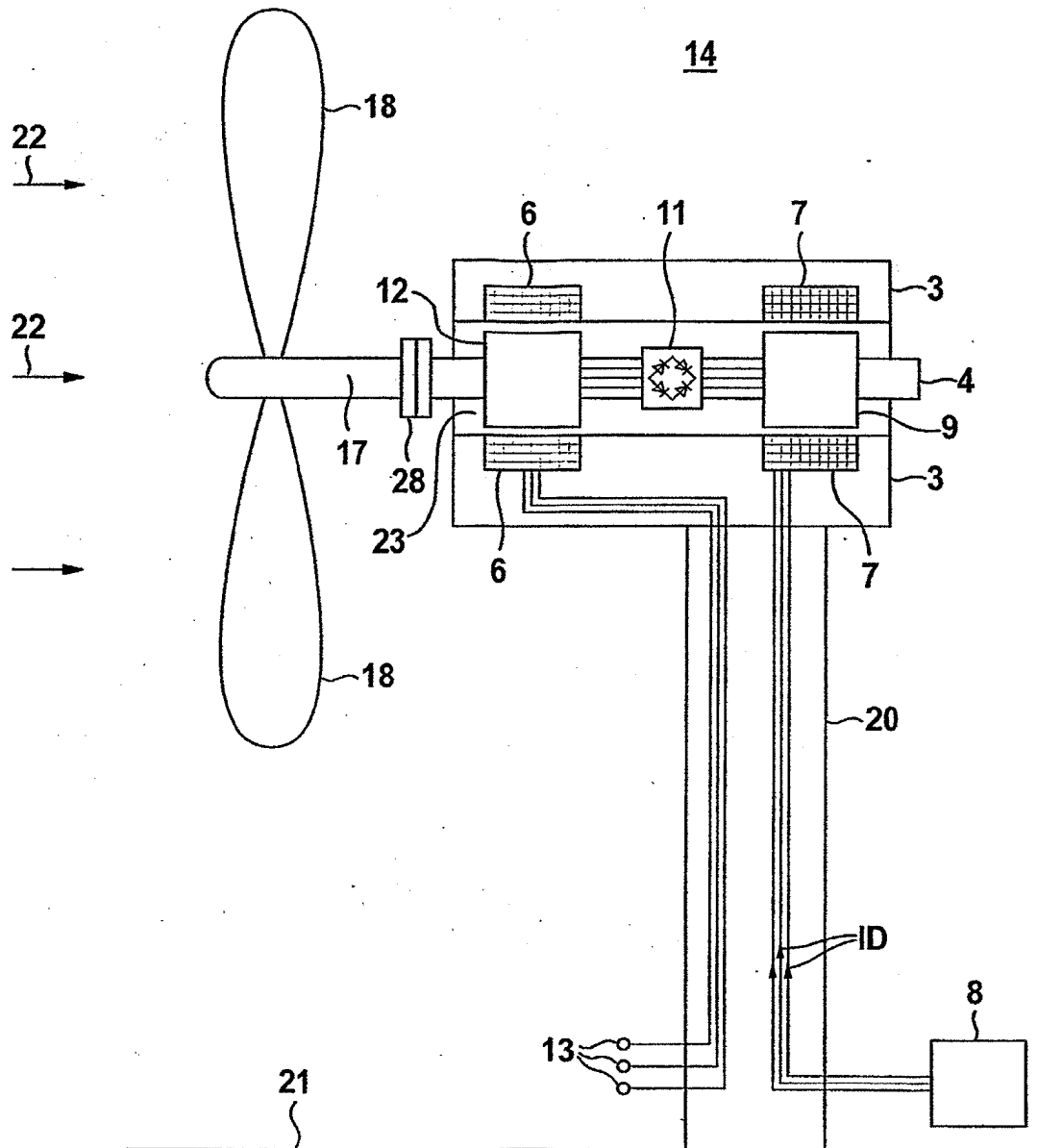


FIG 2

INTERNATIONAL SEARCH REPORT

Intern Application No
PCT/AL 00/00686

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 F03D9/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 F03D H02K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	DE 44 02 184 A (KLINGER FRIEDRICH PROF DR ING) 3 August 1995 (1995-08-03) cited in the application the whole document ---	1
Y	US 5 670 838 A (EVERTON JOHN M) 23 September 1997 (1997-09-23) column 4, line 62 -column 6, line 45; figure 1 ---	1
X	PATENT ABSTRACTS OF JAPAN vol. 2000, no. 01, 31 January 2000 (2000-01-31) -& JP 11 299197 A (SUIDEN CO LTD), 29 October 1999 (1999-10-29) abstract; figures 1,2 --- -/--	1

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

A document defining the general state of the art which is not considered to be of particular relevance

E earlier document but published on or after the international filing date

L document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

O document referring to an oral disclosure, use, exhibition or other means

P document published prior to the international filing date but later than the priority date claimed

T later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

X document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

G document member of the same patent family

Date of the actual completion of the international search

22 December 2000

Date of mailing of the international search report

03/01/2001

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Ingelbrecht, P

INTERNATIONAL SEARCH REPORT

Intern: Application No
PCT/IL 00/00686

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 198 01 803 A (SIEMENS AG) 29 April 1999 (1999-04-29) figure 2	1
X	US 5 814 914 A (CAAMANO RAMON A) 29 September 1998 (1998-09-29) column 8, line 32 -column 9, line 16; figure 1 the whole document	1

INTERNATIONAL SEARCH REPORT

International patent family members

International Application No

PCT/90/00686


Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 4402184 A	03-08-1995	NONE	
US 5670838 A	23-09-1997	AT 144658 T AU 671799 B AU 1870792 A DE 69214812 D DE 69214812 T EP 0587812 A WO 9222121 A GB 2271673 A JP 6507780 T	15-11-1996 12-09-1996 08-01-1993 28-11-1996 15-05-1997 23-03-1994 10-12-1992 20-04-1994 01-09-1994
JP 11299197 A	29-10-1999	NONE	
DE 19801803 A	29-04-1999	NONE	
US 5814914 A	29-09-1998	US 5731649 A US 5903082 A US 5986378 A US 6049197 A US 6154013 A US 5982070 A	24-03-1998 11-05-1999 16-11-1999 11-04-2000 28-11-2000 09-11-1999

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 1011 WO 1		FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/NL00/00686	International filing date (day/month/year) 25/09/2000	Priority date (day/month/year) 24/09/1999	
International Patent Classification (IPC) or national classification and IPC F03D9/00			
Applicant LAGERWEY WINDTURBINE B.V. et al			
<p>1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 4 sheets, including this cover sheet.</p> <p><input type="checkbox"/> This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).</p> <p>These annexes consist of a total of sheets.</p>			
<p>3. This report contains indications relating to the following items:</p> <ul style="list-style-type: none"> I <input checked="" type="checkbox"/> Basis of the report II <input type="checkbox"/> Priority III <input type="checkbox"/> Non-establishment of opinion with regard to novelty, inventive step and industrial applicability IV <input type="checkbox"/> Lack of unity of invention V <input checked="" type="checkbox"/> Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement VI <input type="checkbox"/> Certain documents cited VII <input checked="" type="checkbox"/> Certain defects in the international application VIII <input type="checkbox"/> Certain observations on the international application 			
Date of submission of the demand 12/04/2001		Date of completion of this report 14.01.2002	
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465		Authorized officer Poock, M Telephone No. +49 89 2399 2461	



**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/NL00/00686

I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

Description, pages:

1-11 as originally filed

Claims, No.:

1-8 as originally filed

Drawings, sheets:

1/6-6/6 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/NL00/00686

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**1. Statement**

Novelty (N)	Yes:	Claims
	No:	Claims 1-8
Inventive step (IS)	Yes:	Claims
	No:	Claims 1-8
Industrial applicability (IA)	Yes:	Claims 1-8
	No:	Claims

2. Citations and explanations
see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/NL00/00686

1. DE-A-19 802 803 (D1) discloses a windmill (cf Fig 2) for generating electric current with the aid of a generator which is driven by vanes 18 and is provided with a rotor 4, a stator 6, 7 and a bearing (disclosed implicitly to a skilled person) on which the vanes are also mounted. The stator 6, 7 is positioned in a closed chamber 3 (can be seen in Fig 2) with at least one air seal (disclosed implicitly to a skilled person) between rotating parts and stationary parts of the generator.

only
known

These features are also known from DE-A-4 402 184 (D2).

The subject-matter of claim 1 as such was therefore already known. By consequence, the subject-matter of claim 1 does not meet the requirements of Article 33 (2) EPC.

2. It should be noted that the characterising features of claim 1 are also known from documents US-A-5 670 838 (D3) and US-A-5 814 914 (D4).

In view of the advantages achieved by these generators, it is obvious for the skilled person to combine the teaching of these documents with known windmills and to thus arrive at the solution proposed in claim 1.

Therefore, the subject-matter of claim 1 is not considered as involving an inventive step (Article 33(3) PCT).

3. Dependent claims 2-8 propose features which appear of being already known in the state of the art as cited in the search report or of being matters of normal design procedure for the skilled person. Thus, these claims do not appear to contain any additional features which, in combination with the features of any claim to which they refer, could form subject matter which is new and involves an inventive step.
4. Contrary to the requirements of Rule 5.1(a)(ii), (iii) PCT, the relevant background art disclosed in the documents mentioned in the search report are not mentioned in the description, nor are these documents identified therein, nor is the description consistent with the claims.

WO 01/21956
PCT/NL00/00686

TERMIJN:

- 9 APR. 2001

SIGNAL:

PCT

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

To:

UITTENBOGAART, Gustaaf, Adolf
Indeig B.V.
P.O. Box 3
NL-2050 AA Overveen
PAYS-BASNOTICE INFORMING THE APPLICANT OF THE
COMMUNICATION OF THE INTERNATIONAL
APPLICATION TO THE DESIGNATED OFFICES

(PCT Rule 47.1(c), first sentence)

Date of mailing (day/month/year) 29 March 2001 (29.03.01)		IMPORTANT NOTICE	
Applicant's or agent's file reference 1011 WO 1			
International application No. PCT/NL00/00686	International filing date (day/month/year) 25 September 2000 (25.09.00)	Priority date (day/month/year) 24 September 1999 (24.09.99)	
Applicant LAGERWEY WINDTURBINE B.V. et al			

1. Notice is hereby given that the International Bureau has communicated, as provided in Article 20, the international application to the following designated Offices on the date indicated above as the date of mailing of this Notice:
US

In accordance with Rule 47.1(c), third sentence, those Offices will accept the present Notice as conclusive evidence that the communication of the international application has duly taken place on the date of mailing indicated above and no copy of the international application is required to be furnished by the applicant to the designated Office(s).

2. The following designated Offices have waived the requirement for such a communication at this time:
EP,JP

The communication will be made to those Offices only upon their request. Furthermore, those Offices do not require the applicant to furnish a copy of the international application (Rule 49.1(a-bis)).

3. Enclosed with this Notice is a copy of the international application as published by the International Bureau on 29 March 2001 (29.03.01) under No. WO 01/21956

REMINDER REGARDING CHAPTER II (Article 31(2)(a) and Rule 54.2)

If the applicant wishes to postpone entry into the national phase until 30 months (or later in some Offices) from the priority date, a demand for international preliminary examination must be filed with the competent International Preliminary Examining Authority before the expiration of 19 months from the priority date.

It is the applicant's sole responsibility to monitor the 19-month time limit.

Note that only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination.

REMINDER REGARDING ENTRY INTO THE NATIONAL PHASE (Article 22 or 39(1))

If the applicant wishes to proceed with the international application in the national phase, he must, within 20 months or 30 months, or later in some Offices, perform the acts referred to therein before each designated or elected Office.

For further important information on the time limits and acts to be performed for entering the national phase, see the Annex to Form PCT/IB/301 (Notification of Receipt of Record Copy) and Volume II of the PCT Applicant's Guide.

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer J. Zahra
Facsimile No. (41-22) 740.14.35	Telephone No. (41-22) 338.83.38

PCT/NL00/00686

TERMIN:

10 JUN 2001

SIGNAAL:

PATENT COOPERATION TREATY

PCT

From the INTERNATIONAL BUREAU

To:

UITTENBOGAART, Gustaaf, Adolf
Indeig B.V.
P.O. Box 3
NL-2050 AA Overveen
PAYS-BAS

INFORMATION CONCERNING ELECTED
OFFICES NOTIFIED OF THEIR ELECTION

(PCT Rule 61.3)

Date of mailing (day/month/year) 30 May 2001 (30.05.01)		
Applicant's or agent's file reference 1011 WO 1		IMPORTANT INFORMATION
International application No. PCT/NL00/00686	International filing date (day/month/year) 25 September 2000 (25.09.00)	
Priority date (day/month/year) 24 September 1999 (24.09.99)		
Applicant LAGERWEY WINDTURBINE B.V. et al		

1. The applicant is hereby informed that the International Bureau has, according to Article 31(7), notified each of the following Offices of its election:

EP : AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE
National : JP, US

2. The following Offices have waived the requirement for the notification of their election; the notification will be sent to them by the International Bureau only upon their request:

None

3. The applicant is reminded that he must enter the "national phase" before the expiration of 30 months from the priority date before each of the Offices listed above. This must be done by paying the national fee(s) and furnishing, if prescribed, a translation of the international application (Article 39(1)(a)), as well as, where applicable, by furnishing a translation of any annexes of the international preliminary examination report (Article 36(3)(b) and Rule 74.1).

Some offices have fixed time limits expiring later than the above-mentioned time limit. For detailed information about the applicable time limits and the acts to be performed upon entry into the national phase before a particular Office, see Volume II of the PCT Applicant's Guide.

The entry into the European regional phase is postponed until 31 months from the priority date for all States designated for the purposes of obtaining a European patent.

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer: Olivia TEFY
Facsimile No. (41-22) 740.14.35	Telephone No. (41-22) 338.83.38

RECORD COPY

PCT

REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

For receiving Office use only	
PCT/NL International Application No.	00 / 0068 6
(25.09.00) International Filing Date	25 SEP. 2000
BUREAU VOOR DE INDUSTRIËLE EIGENDOM PCT INTERNATIONAL APPLICATION	
Name of receiving Office and "PCT International Application"	
Applicant's or agent's file reference (if desired) (12 characters maximum) 1011 WO 1	

Box No. I TITLE OF INVENTION

Windmolen

Box No. II APPLICANT

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

Lagerwey Windturbine B.V.
Postbus 279
NL 3770 AG Barneveld
The Netherlands

☐ This person is also inventor.

Telephone No.

+31(0) 342 422724

Facsimile No.

+31(0) 342 422861

Teleprinter No.

State (that is, country) of nationality:

NL

State (that is, country) of residence:

NL

This person is applicant for the purposes of:

☐ all designated States

☒ all designated States except the United States of America

☐ the United States of America only

☐ the States indicated in the Supplemental Box

Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

Lagerwey, Hendrik Lambertus
Tjaskerstraat 9
NL 3774 CT Kootwijkerbroek
The Netherlands

This person is:

☐ applicant only

☒ applicant and inventor

☐ inventor only (If this check-box is marked, do not fill in below.)

State (that is, country) of nationality:

NL

State (that is, country) of residence:

NL

This person is applicant for the purposes of:

☐ all designated States

☐ all designated States except the United States of America

☒ the United States of America only

☐ the States indicated in the Supplemental Box

☒ Further applicants and/or (further) inventors are indicated on a continuation sheet.

Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:

☒ agent

☐ common representative

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)

UITTENBOGAART, Gustaaf Adolf
Indeig B.V.
Postoffice Box 3
NL 2050 AA Overveen
The Netherlands

Telephone No.

+31(0)23 5267034

Facsimile No.

+31(0)23 5258865

Teleprinter No.

☐ Address for correspondence: Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

*
Title
CHANGED
See I.S.R

Δ RO/NL

*

Box No.V DESIGNATION OF STATES

The following designations are hereby made under Rule 4.9(a) (mark the applicable check-boxes; at least one must be marked):

Regional Patent

- ☐ **AP ARIPO Patent:** GH Ghana, GM Gambia, KE Kenya, LS Lesotho, MW Malawi, SD Sudan, SL Sierra Leone, SZ Swaziland, TZ United Republic of Tanzania, UG Uganda, ZW Zimbabwe, and any other State which is a Contracting State of the Harare Protocol and of the PCT
- ☐ **EA Eurasian Patent:** AM Armenia, AZ Azerbaijan, BY Belarus, KG Kyrgyzstan, KZ Kazakhstan, MD Republic of Moldova, RU Russian Federation, TJ Tajikistan, TM Turkmenistan, and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT
- ☒ **EP European Patent:** AT Austria, BE Belgium, CH and LI Switzerland and Liechtenstein, CY Cyprus, DE Germany, DK Denmark, ES Spain, FI Finland, FR France, GB United Kingdom, GR Greece, IE Ireland, IT Italy, LU Luxembourg, MC Monaco, NL Netherlands, PT Portugal, SE Sweden, and any other State which is a Contracting State of the European Patent Convention and of the PCT
- ☐ **OA OAPI Patent:** BF Burkina Faso, BJ Benin, CF Central African Republic, CG Congo, CI Côte d'Ivoire, CM Cameroon, GA Gabon, GN Guinea, GW Guinea-Bissau, ML Mali, MR Mauritania, NE Niger, SN Senegal, TD Chad, TG Togo, and any other State which is a member State of OAPI and a Contracting State of the PCT (if other kind of protection or treatment desired, specify on dotted line)

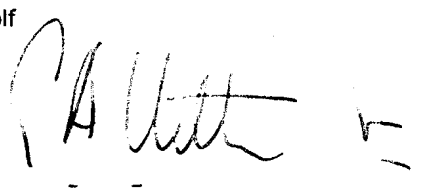
National Patent (if other kind of protection or treatment desired, specify on dotted line):

- | | |
|--|--|
| <input type="checkbox"/> AE United Arab Emirates | <input type="checkbox"/> LR Liberia |
| <input type="checkbox"/> AL Albania | <input type="checkbox"/> LS Lesotho |
| <input type="checkbox"/> AM Armenia | <input type="checkbox"/> LT Lithuania |
| <input type="checkbox"/> AT Austria | <input type="checkbox"/> LU Luxembourg |
| <input type="checkbox"/> AU Australia | <input type="checkbox"/> LV Latvia |
| <input type="checkbox"/> AZ Azerbaijan | <input type="checkbox"/> MA Morocco |
| <input type="checkbox"/> BA Bosnia and Herzegovina | <input type="checkbox"/> MD Republic of Moldova |
| <input type="checkbox"/> BB Barbados | <input type="checkbox"/> MG Madagascar |
| <input type="checkbox"/> BG Bulgaria | <input type="checkbox"/> MK The former Yugoslav Republic of Macedonia |
| <input type="checkbox"/> BR Brazil | |
| <input type="checkbox"/> BY Belarus | <input type="checkbox"/> MN Mongolia |
| <input type="checkbox"/> CA Canada | <input type="checkbox"/> MW Malawi |
| <input type="checkbox"/> CH and LI Switzerland and Liechtenstein | <input type="checkbox"/> MX Mexico |
| <input type="checkbox"/> CN China | <input type="checkbox"/> NO Norway |
| <input type="checkbox"/> CR Costa Rica | <input type="checkbox"/> NZ New Zealand |
| <input type="checkbox"/> CU Cuba | <input type="checkbox"/> PL Poland |
| <input type="checkbox"/> CZ Czech Republic | <input type="checkbox"/> PT Portugal |
| <input type="checkbox"/> DE Germany | <input type="checkbox"/> RO Romania |
| <input type="checkbox"/> DK Denmark | <input type="checkbox"/> RU Russian Federation |
| <input type="checkbox"/> DM Dominica | <input type="checkbox"/> SD Sudan |
| <input type="checkbox"/> EE Estonia | <input type="checkbox"/> SE Sweden |
| <input type="checkbox"/> ES Spain | <input type="checkbox"/> SG Singapore |
| <input type="checkbox"/> FI Finland | <input type="checkbox"/> SI Slovenia |
| <input type="checkbox"/> GB United Kingdom | <input type="checkbox"/> SK Slovakia |
| <input type="checkbox"/> GD Grenada | <input type="checkbox"/> SL Sierra Leone |
| <input type="checkbox"/> GE Georgia | <input type="checkbox"/> TJ Tajikistan |
| <input type="checkbox"/> GH Ghana | <input type="checkbox"/> TM Turkmenistan |
| <input type="checkbox"/> GM Gambia | <input type="checkbox"/> TR Turkey |
| <input type="checkbox"/> HR Croatia | <input type="checkbox"/> TT Trinidad and Tobago |
| <input type="checkbox"/> HU Hungary | <input type="checkbox"/> TZ United Republic of Tanzania |
| <input type="checkbox"/> ID Indonesia | <input type="checkbox"/> UA Ukraine |
| <input type="checkbox"/> IL Israel | <input type="checkbox"/> UG Uganda |
| <input type="checkbox"/> IN India | <input checked="" type="checkbox"/> US United States of America |
| <input type="checkbox"/> IS Iceland | |
| <input checked="" type="checkbox"/> JP Japan | <input type="checkbox"/> UZ Uzbekistan |
| <input type="checkbox"/> KE Kenya | <input type="checkbox"/> VN Viet Nam |
| <input type="checkbox"/> KG Kyrgyzstan | <input type="checkbox"/> YU Yugoslavia |
| <input type="checkbox"/> KP Democratic People's Republic of Korea | <input type="checkbox"/> ZA South Africa |
| | <input type="checkbox"/> ZW Zimbabwe |

Check-boxes reserved for designating States which have become party to the PCT after issuance of this sheet:

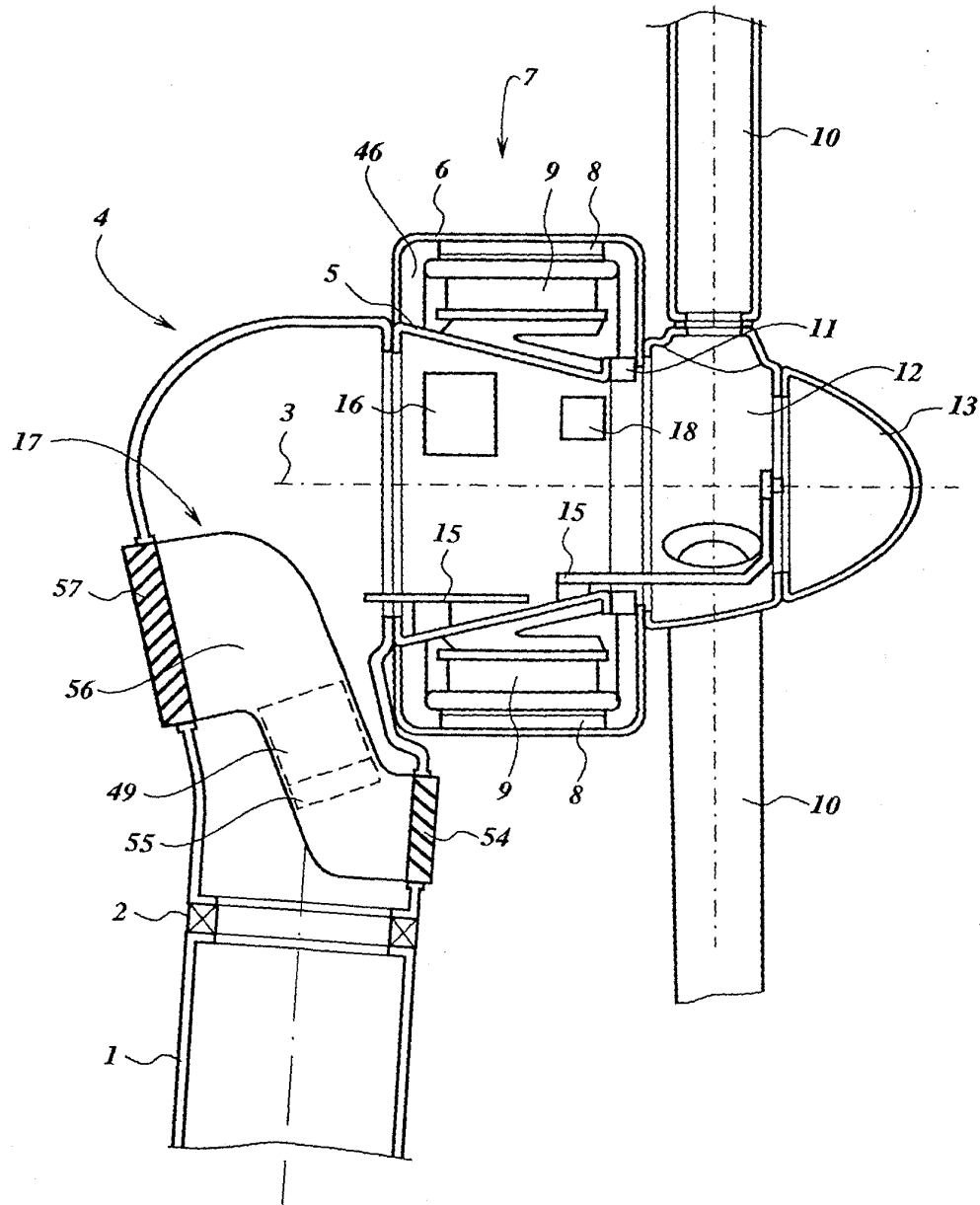
- ☐
- ☐

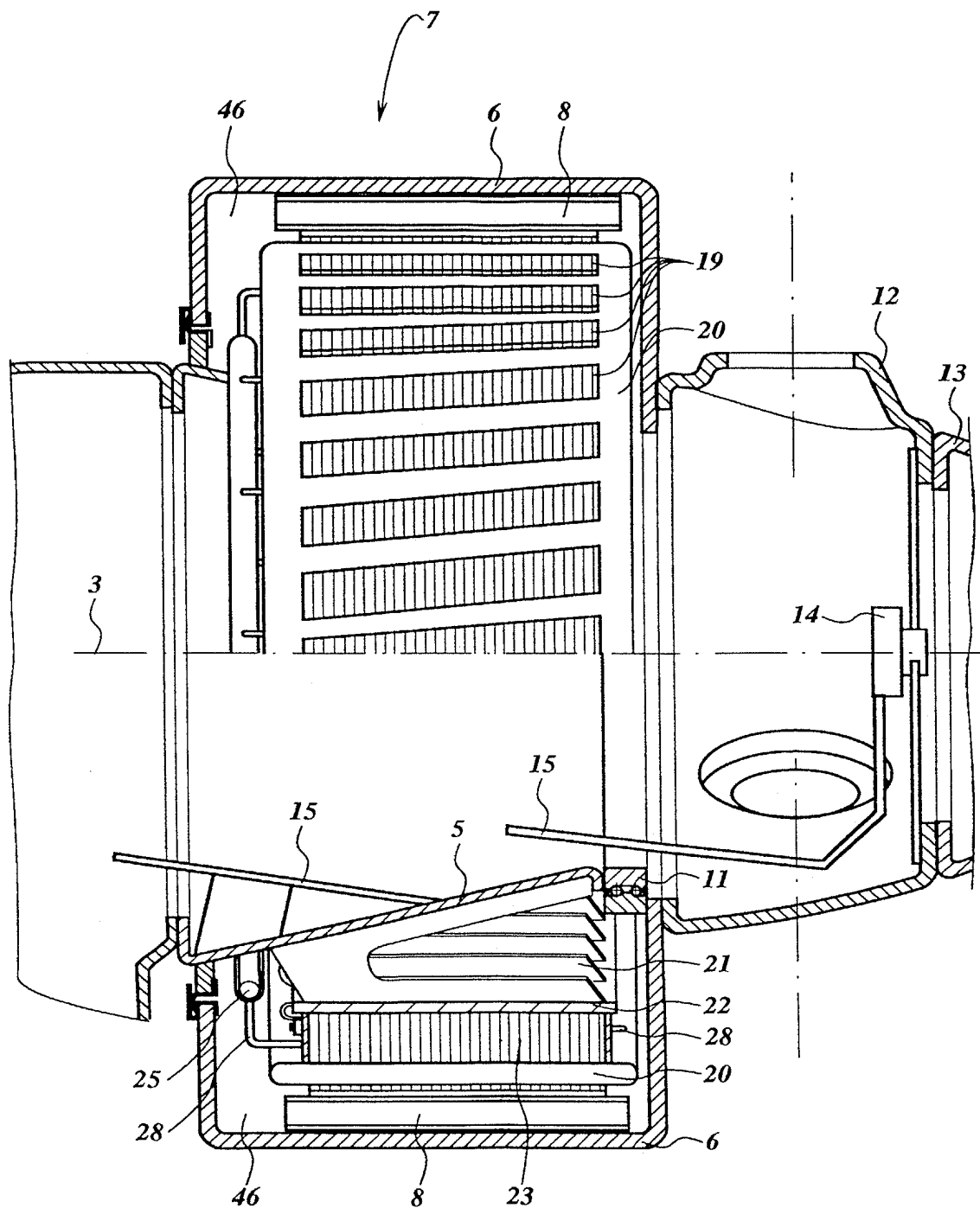
Precautionary Designation Statement: In addition to the designations made above, the applicant also makes under Rule 4.9(b) all other designations which would be permitted under the PCT except any designation(s) indicated in the Supplemental Box as being excluded from the scope of this statement. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit. (Confirmation (including fees) must reach the receiving Office within the 15-month time limit.)

Box No. VI PRIORITY CLAIM		<input type="checkbox"/> Further priority claims indicated in the Supplemental Box.		
Filing date of earlier application (day/month/year) (24.09.99)	Number of earlier application 1013129	Where earlier application is:		
		national application: country	regional application: * regional Office	international application: receiving Office
item (1) 24 september 1999	1013129	NL		
item (2)				
item (3)				
<input checked="" type="checkbox"/> The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) (only if the earlier application was filed with the Office which for the purposes of the present international application is the receiving Office) identified above as item(s): 1				
<small>* Where the earlier application is an ARIPO application, it is mandatory to indicate in the Supplemental Box at least one country party to the Paris Convention for the Protection of Industrial Property for which that earlier application was filed (Rule 4.10(b)(ii)). See Supplemental Box.</small>				
Box No. VII INTERNATIONAL SEARCHING AUTHORITY				
Choice of International Searching Authority (ISA) <small>(if two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used):</small>		Request to use results of earlier search; reference to that search (if an earlier search has been carried out by or requested from the International Searching Authority):		
ISA / EPO		Date (day/month/year) 10 mei 2000	Number SN 33968 NL	Country (or regional Office) NL EPO
Box No. VIII CHECK LIST; LANGUAGE OF FILING				
This international application contains the following number of sheets: request : 3 sheets description (excluding sequence listing part) : 12 claims : 2 abstract : 1 drawings : 6 sequence listing part of description : - Total number of sheets : 24		This international application is accompanied by the item(s) marked below: 1. <input checked="" type="checkbox"/> fee calculation sheet 2. <input type="checkbox"/> separate signed power of attorney 3. <input type="checkbox"/> copy of general power of attorney; reference number, if any: 4. <input type="checkbox"/> statement explaining lack of signature 5. <input type="checkbox"/> priority document(s) identified in Box No. VI as item(s): 6. <input type="checkbox"/> translation of international application into (language): 7. <input type="checkbox"/> separate indications concerning deposited microorganism or other biological material 8. <input type="checkbox"/> nucleotide and/or amino acid sequence listing in computer readable form 9. <input type="checkbox"/> other (specify):		
Figure of the drawings which should accompany the abstract: 1		Language of filing of the international application: NL		
Box No. IX SIGNATURE OF APPLICANT OR AGENT				
<small>Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).</small>				
Uittenbogaart, Gustaaf Adolf  25.09.00.				

For receiving Office use only		2. Drawings: <input checked="" type="checkbox"/> received: <input type="checkbox"/> not received:
1. Date of actual receipt of the purported international application:	(25.09.00) 25 SEP. 2000	
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:		
4. Date of timely receipt of the required corrections under PCT Article 11(2):		
5. International Searching Authority (if two or more are competent): ISA /	6. <input type="checkbox"/> Transmittal of search copy delayed until search fee is paid.	

For International Bureau use only	
Date of receipt of the record copy by the International Bureau:	09 NOVEMBER 2000 (09.11.00)

*Fig. 1*

*Fig. 2*

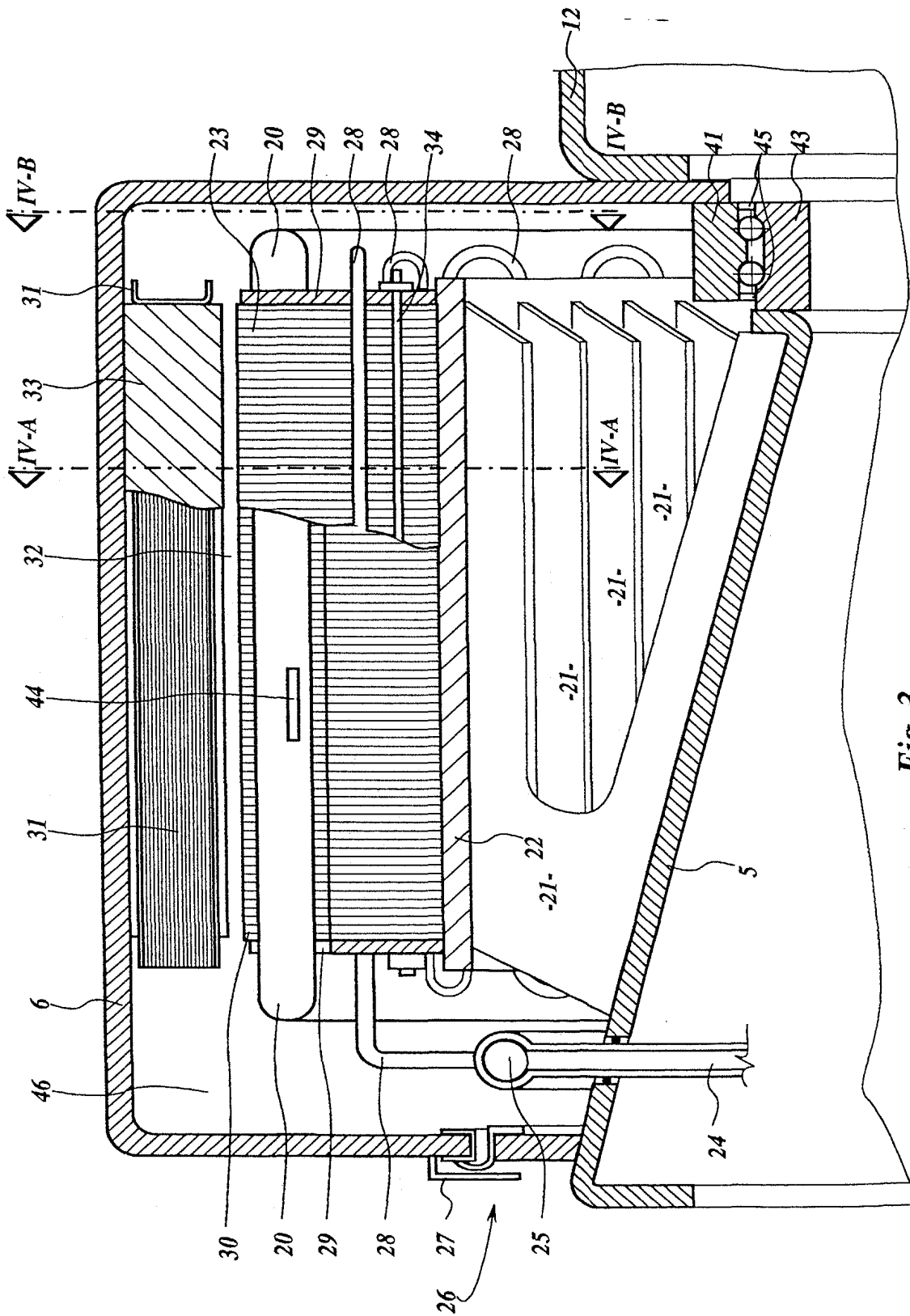


Fig. 3

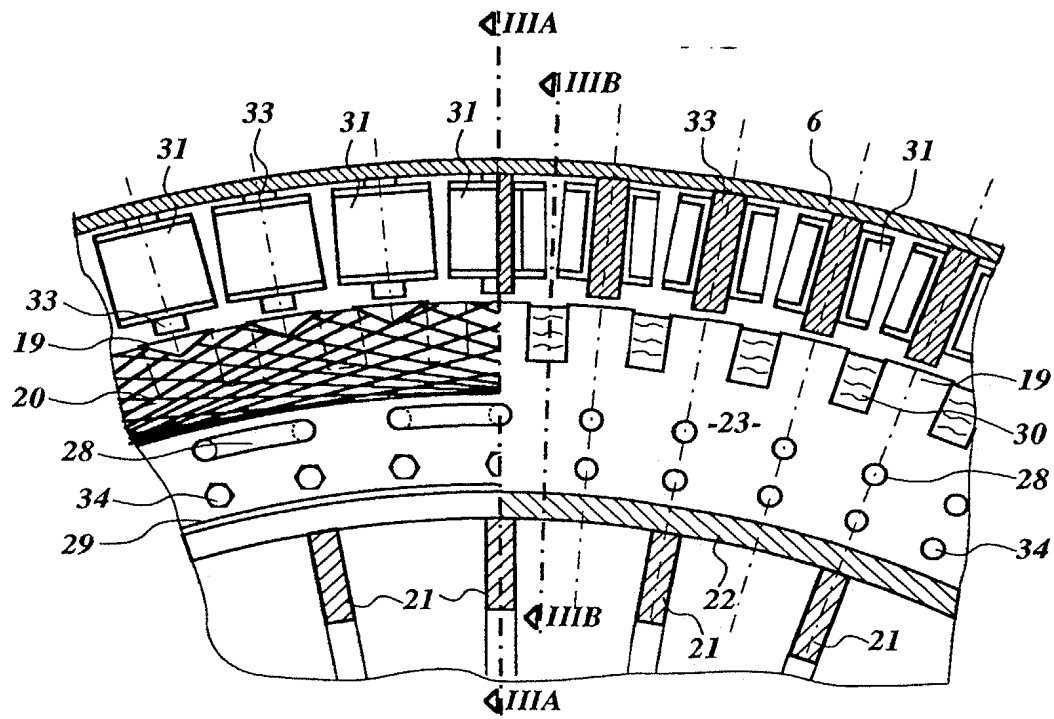


Fig. 4

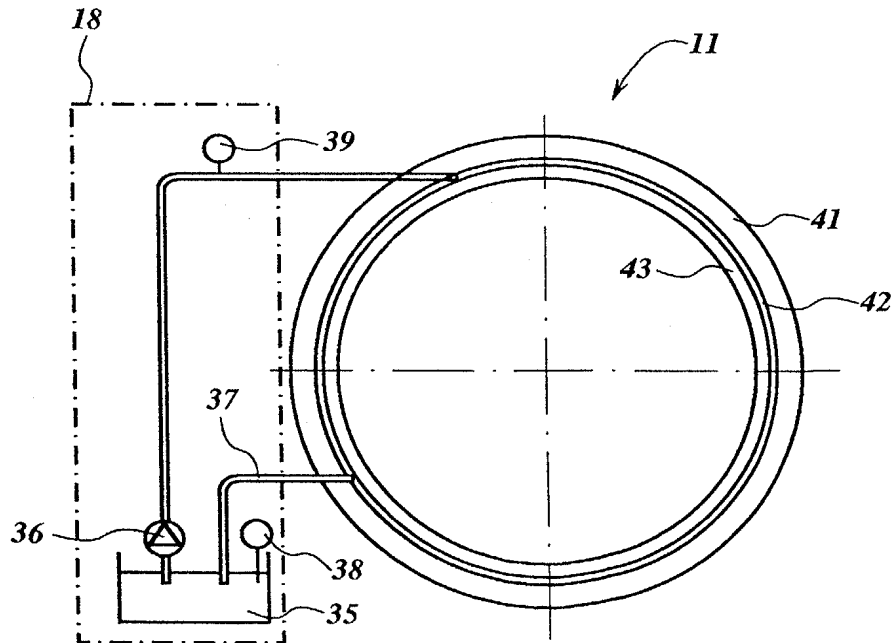
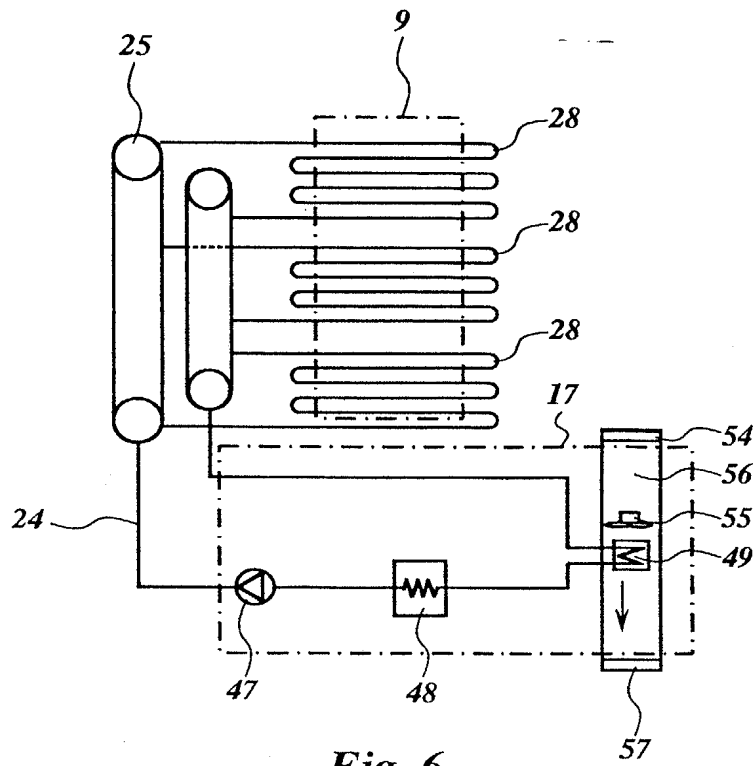
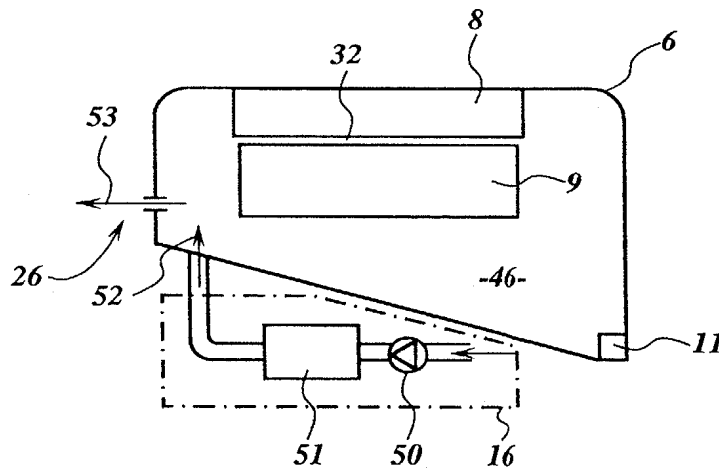


Fig. 5

*Fig. 6**Fig. 7*

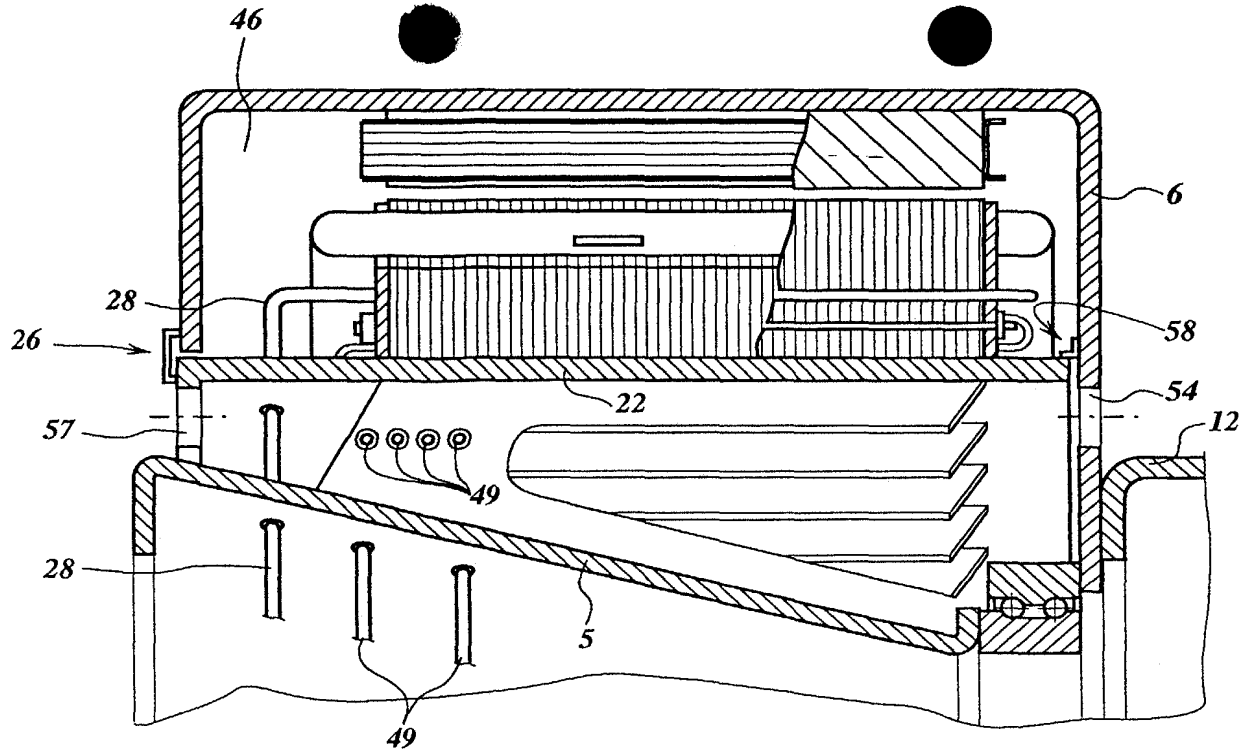


Fig. 8

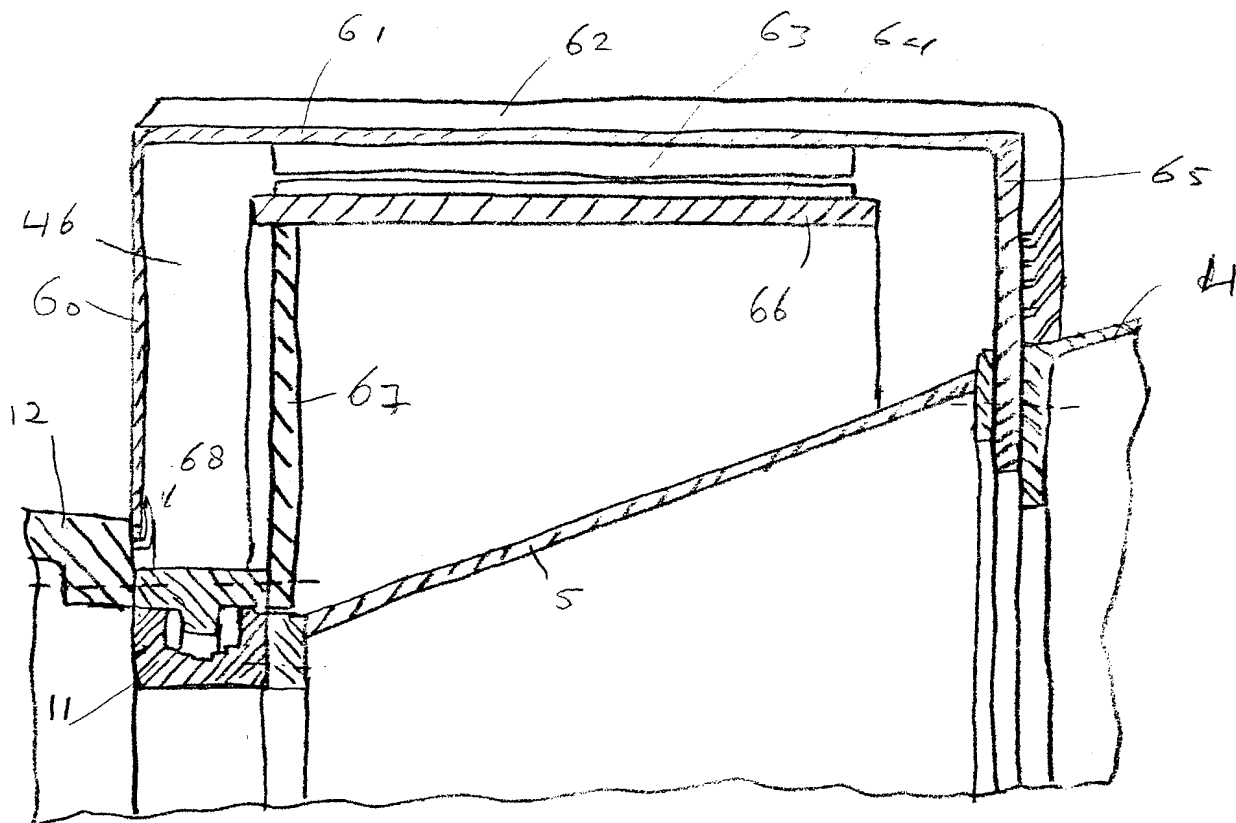


Fig. 9

Windmolen

De uitvinding betreft een windmolen overeenkomstig de aanhef van conclusie 1. Een dergelijke windmolen is bekend uit DE 4402184. Bij de bekende inrichting is het
5 mogelijk dat vochtafzetting plaats vindt op de wikkelingen van de generator in de periode dat de windmolen stil staat. Voordat de windmolen dan in gebruik genomen kan worden, moet de stator opgewarmd worden om het vocht te verdrijven, omdat anders in de wikkelingen van de stator
10 kortsluiting op kan treden. Dit opwarmen kost veel tijd, zodat de tijd dat de windmolen nuttig gebruikt kan worden nadelig beïnvloed wordt. Teneinde dit nadeel te vermijden is de inrichting uitgevoerd overeenkomstig het kenmerk van conclusie 1. Hierdoor wordt toevoer van vochtige
15 lucht in de ruimte rondom de stator verhinderd, zodat vochtafzetting vermindert.

Overeenkomstig een verbetering is de inrichting uitgevoerd overeenkomstig conclusie 2. Hierdoor wordt het risico van condens op de stator verder verminderd.

20 Overeenkomstig een verbetering is de inrichting uitgevoerd overeenkomstig conclusie 3. Hierdoor wordt toevoer van vochtige lucht in de afgesloten ruimte voorkomen.

Overeenkomstig een verbetering is de inrichting uitgevoerd overeenkomstig conclusie 4. Hierdoor wordt het
25 drogen van de lucht alleen gebruikt als er gevaar voor condensvorming is, zodat de slijtage aan de luchtdroger beperkt wordt.

Overeenkomstig een verbetering is de inrichting uitgevoerd overeenkomstig conclusie 5. Hierdoor wordt be-
30 reikt dat de stator rondom een gelijkmatige temperatuur heeft en er niet plaatselijk condensvorming op kan tre-

den. Ook wordt onrondheid van de stator vermeden zodat de luchtspleet kleiner gehouden kan worden.

Overeenkomstig een uitvoering is de windmolen uitgevoerd volgens conclusie 6. Hierdoor is er geen luchttoevoer of afvoer mogelijk langs het lager en kan in de gesloten ruimte eventueel een overdruk worden aangebracht.

Overeenkomstig een uitvoering is de windmolen uitgevoerd volgens conclusie 7. Hierdoor wordt controle op de aanwezigheid van smeermiddel in het lager vereenvoudigd, zodat de afdichtingen geen schade lijden door gebrek aan smeermiddel.

Overeenkomstig een verbetering is de inrichting uitgevoerd volgens conclusie 7. Hierdoor is het op eenvoudige wijze mogelijk steeds te controleren dat het lager en de afdichtingen op de juiste wijze gesmeerd zijn, en indien noodzakelijk maatregelen te nemen.

De uitvinding wordt hierna toegelicht aan de hand van een uitvoeringsvoorbeeld met behulp van een tekening waarbij

figuur 1 een schematische doorsnede van een windmolen toont,

figuur 2 een doorsnede en gedeeltelijk aanzicht toont van een deel van de windmolen van figuur 1 toont,

figuur 3 een dwarsdoorsnede toont van de generator van de windmolen van figuur 1,

figuur 4 een langsdoorsnede toont van de generator van de windmolen van figuur 1,

figuur 5 schematisch de smeereenheid van het lager van de windmolen van figuur 1 toont,

figuur 6 schematisch de koeleenheid van de generator van de windmolen van figuur 1 toont,

figuur 7 schematisch de luchttoevoer naar de generatorruimte van de windmolen van figuur 1 toont,

figuur 8 een tweede uitvoering van het luchtkanaal van de koeleenheid toont, en

figuur 9 een tweede uitvoering van de generator van de windmolen van figuur 1 toont.

5 Figuur 1 toont de doorsnede van een gondel 4 van een windmolen. De gondel 4 is met een lager 2 geplaatst op een mast 1. De gondel 4 omvat een om een conische bus 5 gemonteerde generator 7. Op de conische bus 5 is een stator 9 gemonteerd en een hoofdlager 11 dat kan roteren om
10 een rotatieas 3. Aan het roterende deel van het hoofdlager 11 is een rotor 8 bevestigd, die aan de buitenzijde van de stator 9 is aangebracht. De buitenomtrek van de generator 7 is afgedekt met een generatorkap 6, die met de rotor 8 roteert, waardoor een generatorruimte 46 ge-
15 vormd wordt.

Aan het roterende deel van het hoofdlager 11 is eveneens een wiekendrager 12 bevestigd, waaraan drie wieken 10 zijn bevestigd, welke wieken 10 zijn voorzien van een niet getoonde wiekverstelling. Voor de stroomvoorziening van de rotor 8 en de wiekverstellingen is een
20 sleepringhouder 14 met sleepringen geplaatst. De voorziening van de wiekendrager 12 is afgeschermd met een neuskap 13.

In de gondel 4 is ter plaatse van de conische bus 5
25 voor bedienend personeel een platform 15 aangebracht. Er zijn in de gondel 4 tevens een luchteenheid 16, een koeleenheid 17 en een smeereenheid 18 aangebracht. De luchteenheid 16 verzorgt de toevoer van lucht naar de generatorruimte 46, waarbij deze lucht bij voorkeur gedroogd
30 wordt om vocht in de wikkelingen van de generator 7 te voorkomen.

De koeleenheid 17 zorgt op nader aan te geven wijze voor het circuleren van koelvloeistof door de stator 9

van de generator, waardoor warmte uit de generator 7
wordt afgevoerd. In de stator 9 van de generator wordt
veel warmte ontwikkeld, welke warmte direct moet worden
afgevoerd. Daartoe is in de koeleenheid 17 een warmtewis-
5 selaar 49 geplaatst, die in een luchtkanaal 56 is opgeno-
men. Het luchtkanaal 56 loopt van een koelluchtinlaat 54,
die is aangebracht aan de windzijde van de gondel 4, naar
een koellucht uitlaat 57 die geplaatst is aan de lijzijde
van de gondel 4. Het luchtkanaal 56 is een min of meer
10 gesloten kanaal zodat de koellucht die zout en vochtig
kan zijn, niet in de gondel 4 komt. Eventueel is in het
luchtkanaal 56 een ventilator 55 geplaatst, zodat de af-
metingen van het luchtkanaal 56 en de warmtewisselaar 49
kleiner gehouden kunnen worden bij dezelfde koelcapaci-
15 teit. Eventueel kan tijdens of na langdurige stilstand
bijvoorbeeld ten gevolge van windstilte aan de circule-
rende koelvloeistof warmte toegevoerd worden om de wikke-
lingen van de stator 9 warm te houden of te verwarmen zo-
dat condens niet ontstaat of verdwijnt.

20 De smeereenheid 18 zorgt voor de juiste smering van
het hoofdlager 11. Bovendien zijn in de gondel 4 diverse
niet nader omschreven besturings- en beveiligingseenheden
aangebracht, zoals voor het besturen van de wiekverstel-
ling, en voor het besturen van de hiervoor genoemde een-
25 heden. Voorts is er een niet getoonde rem en eventueel
een blokkeringpen voor het tijdens onderhoud stilzetten
van de wieken 10 van de windmolen.

In het getoonde uitvoeringsvoorbeeld van de windmo-
len is de mast 1 ongeveer 70 meter hoog en heeft een dia-
30 meter van 2 meter. De diameter van de wieken 10 is 70 me-
ter, de diameter van het hoofdlager 11 is ongeveer 1.800
millimeter en de diameter van de generator is 3.800 mil-
limeter. Het door de generator 9 opgewekte vermogen is
bij een rotatiesnelheid van de rotor van 18 omwentelingen

per minuut nominaal 1.500 kilowatt en bij 24 omwentelingen per minuut nominaal 2.000 kilowatt.

Figuur 2 toont de generator 7. In de onderste helft van de figuur is de stator 9 in doorsnede getoond. Om de conische bus 5 is een steunring 22 bevestigd met steunplaten 21. Om de steunring 22 is een statorpakket 23 bevestigd, dat op bekende wijze is opgebouwd uit platen weekijzer. In de buitenomtrek van het statorpakket 23 zijn wikkelingssleuven 30 aangebracht tussen statorpolen 19, zie figuur 3, waardoor de wikkelingen van een statorspoel 20 lopen. In de bovenste helft van de figuur is de statorspoel 20 in buitenaanzicht getoond, waarbij zichtbaar is dat de statorpolen 19 een hoek van ongeveer 5 graden maken met de rotatieas 3. Door deze hoek maken de statorpolen 19 ook een hoek met de evenwijdig aan de rotatieas 3 geplaatste magneten van de rotor 8. Dit heeft tot gevolg dat de generator rustig loopt.

Figuren 3 en 4 tonen de generator 7 meer in detail waarbij figuur 3 de doorsneden IIIA en IIIB van figuur 4 toont en figuur 4 de doorsnede IVA en het aanzicht IVB van figuur 3. Om de steunring 22 is het statorpakket 23 aangebracht, waarbij het statorpakket 23 is voorzien van statorpolen 19 en daartussen wikkelingssleuven 30. De wikkelingen door de wikkelingssleuven 30 vormen tezamen de statorspoel 20. Het statorpakket 23 is opgebouwd uit platen die met trekstangen 34 tussen klemplaten 29 worden geklemd. Door het statorpakket 23 lopen koelleidingen 29 die via een verdeelleiding met een toevoerleiding 24 en een afvoerleiding zijn verbonden.

Aan de generatorkap 6 zijn magneetkernen 33 op bekende wijze bevestigd. Om elke magneetkern 33 is een spoel 31 geplaatst, die tijdens gebruik op bekende wijze bekrachtigd wordt met een veldstroom, zodat bij rotatie

van de rotor 8 in een luchtspleet 32 tussen de statorpo-
len 19 en de magneetkernen 33 veranderende magnetische
velden ontstaan, waarmee in de statorspoel 20 elektrische
spanning en een elektrische stroom wordt opgewekt. Onder
5 andere door de opgewekte elektrische stroom in de wikke-
lingen wordt in de stator 9 warmte ontwikkeld die moet
worden afgevoerd. De temperatuur in de wikkelingen wordt
gemeten met een temperatuursensor 44. Bij te hoge tempe-
ratuur, bijvoorbeeld als deze boven de 40° Celsius komt,
10 wordt de koeleenheid 17 ingeschakeld. De koeleenheid 17
is bijvoorbeeld voorzien van een regelaar voor het con-
stant houden van de temperatuur van de stator 9. Hierdoor
blijft de temperatuur van de statorspoel 20 laag, waar-
door de weerstand in de bedrading van de wikkelingen niet
15 stijgt en het rendement niet nadelig wordt beïnvloed. De
warmte die in de roterende magneetspoelen 31 en de mag-
neetkern 33 ontstaat, wordt via de magneetkern 33 afge-
voerd naar de generatorkap 6 en vandaar naar de atmos-
feer. Mede door het op 40° Celsius houden van de tempera-
20 tuur in de stator 9 wordt de temperatuur van de door de
stator 9 omsloten ruimte ook niet warmer en blijft de
temperatuur van de in de gondel 4 geplaatste apparatuur
en van het hoofdlager 11 voldoende laag, zodat daarvoor
geen aanvullende koeling moet worden voorzien.

25 Na windstilte is er kans dat op de windingen van de
statorspoel 20 vocht is gecondenseerd. Bij in bedrijf ne-
men komt er op de statorspoel 20 een hoge spanning te
staan en er is dan het risico dat kortsluiting in de win-
dingen optreedt waarna de installatie defect is. Ten ein-
30 de dit risico te verminderen wordt het neerslaan van
vocht voorkomen of wordt neergeslagen vocht door verwar-
men verdreven door het verwarmen van de statorspoel 20
voor in bedrijf nemen. Dit verwarmen kan met speciale
windingen in de spoel die als elektrisch verwarming func-

tioneren. Een andere uitvoering is om de statorspoel 20 met de vloeistof in de koelleiding 28 te verwarmen. Door de statorspoel 20 rondom gelijkmatig te verwarmen wordt vermeden dat plaatselijk koude plaatsen ontstaan, waarop
5 zich condens kan vormen.

De rotor heeft spoelen 31 die op eenvoudige wijze elektrisch verwarmd kunnen worden door stroom door de spoelen 31 te sturen, waarbij opwekken van stroom in de stator 9 voorkomen wordt door de spoelen 31 bijvoorbeeld
10 te bekrachtigen met wisselstroom.

Een bijkomend voordeel van het gelijkmatig verwarmen en op gelijkmatige temperatuur houden van de stator 9 is dat deze rondom dezelfde temperatuur houdt en dus door de binnen nauwe grenzen geregelde temperatuur rondom gelijk-
15 matig en beperkt uitzet. Hierdoor zal de luchtspleet 32 rondom dezelfde waarde houden en door uitzetten niet plaatselijk te klein worden. Hierdoor kan de luchtspleet 32 klein gehouden worden, hetgeen het rendement van de generator 7 positief beïnvloedt.

20 Het risico van condens op de statorspoel 20 wordt verder verminderd door er voor te zorgen dat de generatorruimte 46 alleen droge lucht bevat, hetgeen vooral nuttig is als de windmolen bijvoorbeeld nabij of in zee is geplaatst. Daartoe is het hoofdlager 11 op bekende
25 wijze voorzien van afdichtingen 45 en is tussen de roterende generatorkap 6 en de stilstaande conische ring 5 een afdichting 26 geplaatst en zijn alle andere openingen van de generatorruimte 46 afgedicht. De afdichting 26 is voorzien van een stofkap 27, zodat het rubber van de af-
30 dichting beschermd is tegen invloeden van zon en andere weersinvloeden. Teneinde te voorkomen dat bij temperatuurswisselingen lucht van buiten in generatorruimte 46 gezogen wordt, zorgt de luchteenheid 16 voor een eventu-

eel beperkte overdruk in de generatorruimte 46 door toevoer van lucht uit de gondel 4, welke lucht zo droog mogelijk is en bij voorkeur nog extra gedroogd wordt met een luchtdroger. Eventueel is de luchteenheid 16 zodanig
5 uitgevoerd dat lucht uit de generatorruimte 46 wordt gezogen. Deze lucht wordt vervolgens in de luchteenheid 16 vermengd met een beperkte hoeveelheid lucht van buiten of uit de gondel 4 en vervolgens gedroogd en in de generatorruimte 46 gebracht. Eventueel is de luchteenheid 16
10 voorzien van schakelmiddelen waardoor deze alleen wordt ingeschakeld bij stilstand van de windmolen. Doordat tijdens het in bedrijf zijn van de windmolen de stator voldoende warm is, is er dan geen gevaar voor condensvorming, zodat slijtage aan de luchteenheid vermindert. Ook
15 kunnen in de generatorruimte 46 niet getoonde sensoren aangebracht zijn waarmee het dauwpunt van de lucht kan worden gemeten. Nadert de lucht het dauwpunt, bijvoorbeeld door afkoeling, dan schakelt de luchteenheid 16 in zodat condensvorming voorkomen wordt.

20 In het uitvoeringsvoorbeeld is een generator 7 beschreven waarbij de luchtspleet 32 een ronde cilinder is. Het is ook mogelijk om op vergelijkbare wijze een generator te maken waarbij de luchtspleet 32 kegelvormig is, zodat de generator 7 beter de vorm van de conische bus 5
25 volgt en eventueel gewichtsbesparing mogelijk is. De getoonde generator 7 is uitgevoerd met achtenveertig statorpolen 19 en achtenveertig magneetspoelen 31. Vanzelfsprekend kan de generator ook anders uitgevoerd worden, bijvoorbeeld met permanente magneten in plaats van de
30 hier getoonde rotor 8, waarbij er voorzieningen kunnen zijn in de vorm van bijvoorbeeld een verplaatsbare roestvaststalen bus voor het onderbreken van de magnetische veldlijnen bij uitschakelen van de windmolen.

Voor probleemloos bedrijf van de windmolen is het van belang dat het hoofdlager 11 ononderbroken voorzien wordt van smeermiddel. Daartoe is een smeereenheid 18 beschikbaar waarvan de werking getoond is in figuur 5. Het
5 hoofdlager 11 heeft een buitenring 41, een binnenring 43, een kogelbaan 42 en afdichtingen 45 (zie figuur 3). Bovenin het hoofdlager 11 mondt een toevoerleiding 40 in de kogelbaan 42 uit, en halverwege de onderkant en het midden van het hoofdlager 11 is een retourleiding 37 aangesloten aan de kogelbaan 42. Met een pomp 36 wordt olie
10 uit een buffervat 35 in de toevoerleiding 40 gepompt, waarbij met een druk en/of stromingssensor 39 gecontroleerd wordt of olie verpompt wordt. In de kogelbaan 42 gepompte olie stroomt retour in het buffervat 35. Indien
15 door bijvoorbeeld lekkage van de afdichting 45 onvoldoende olie retour komt in het buffervat 45 daalt het niveau. Dit wordt gesignaleerd met een niveausensor 38, zodat tijdig onderhoud gepleegd kan worden. Het hoofdlager 11 houdt voorlopig genoeg olie omdat er olie onder in de kogelbaan 42 blijft staan. Eventueel is in het lager een
20 sensor aangebracht dat warmlopen van het lager detecteert waarna de windmolen gestopt wordt.

Figuur 6 toont schematisch het systeem voor de temperatuurregeling van de stator 9, waarbij bekende onderdelen van een dergelijk circulatiesysteem waaronder een
25 vloeistofbuffer, sensoren, thermostaatkranen, afsluiters en andere besturingsmiddelen niet zijn aangegeven. Aangezien dit systeem essentieel is voor het opwekken van elektriciteit zijn waar nodig de diverse onderdelen dubbel uitgevoerd, zodat stilstand van de windmolen ten gevolge van uitval van een component wordt vermeden. Met
30 een circulatiepomp 47 wordt vloeistof door de toevoerleiding 24 en de verdeelleiding 25 naar de koelleidingen 28 gepompt. De uit de stator 9 komende vloeistof wordt in

een warmtewisselaar 49 geleid en daar door luchtcirculatie gekoeld. De warmtewisselaar 49 is geplaatst in het gesloten luchtkanaal 56 waardoor buitenlucht kan stromen. De stroming van de buitenlucht door de warmtewisselaar 49 vindt plaats door de wind die op de koellucht uitlaat 54 blaast, eventueel geholpen door thermische circulatie omdat verwarmde lucht stijgt naar de koellucht uitlaat 57, die hoger geplaatst is dan de koelluchtinlaat 54. Eventueel is in het luchtkanaal 56 een ventilator geplaatst, die bijvoorbeeld ingeschakeld wordt als extra koeling noodzakelijk is. De warmtewisselaar 49 kan bijvoorbeeld ook uitgevoerd zijn als deel van de wand van de gondel 4 waarbij de warmte door aan de buitenzijde langsstromende lucht wordt afgevoerd. Eventueel wordt de circulerende vloeistof in een verwarming 48 opgewarmd, zodat de stator 9 verwarmd kan worden. Voor de bedrijfszekerheid kunnen de circulatiepomp 47 en de warmtewisselaar 49 dubbel zijn uitgevoerd.

Het luchtkanaal 56 kan ook anders uitgevoerd worden zoals getoond in figuur 8. Hierbij is het luchtkanaal 56 gevormd door de conische bus 5 en de steunring 22, die dan wordt verbreed tot aan de voor en achterzijde van de generatorkap 6. Er is dan een afdichting 26 aan de achterzijde en een vergelijkbare afdichting 58 aan de voorzijde, zodat de generatorruimte 46 gesloten blijft. In de ruimte tussen de conische bus 5 en de steunring 22 is dan ook de warmtewisselaar 49 geplaatst. Aan de voorzijde is de generatorkap 6 voorzien van koelluchtinlaten 54 en aan de achterzijde zijn openingen voorzien als koelluchtuitlaten 57. Ook zijn niet getoonde middelen voorzien voor afvoer van de in ruimte waaiende regen.

Figuur 7 toont schematisch de werking van de voorziening voor het onder overdruk houden van de generatorruimte 46. De generatorruimte 46 is min of meer lucht-

5 dicht en lucht die er met een ventilator 50 via een
luchttoevoer 52 ingeblazen wordt kan er alleen via een
luchtafvoer 53 uit, welke luchtafvoer 53 bijvoorbeeld
plaats vindt ter plaatse van de afdichting 26. Bij voor-
keur wordt een luchtdroger 51 toegepast, zodat het vocht-
gehalte van de lucht in de generatorruimte 46 laag
blijft. In een andere uitvoering is de luchteenheid 16
zodanig uitgevoerd dat de in de generatorruimte 46 aanwe-
zige hoeveelheid lucht door de ventilator 50 wordt aange-
10 zogen, tegelijk met een kleine hoeveelheid buitenlucht
die noodzakelijk is voor het onder overdruk houden van de
generatorruimte 46. De aangezogen lucht wordt in de
luchtdroger 51 gedroogd en in de generatorruimte 46 ge-
bracht.

15 In figuur 9 is een tweede uitvoering van de genera-
tor van de windmolen van figuur 1 getoond. Ook hier is
het hoofdlager 11 door de conische bus 5 gekoppeld aan de
gondel 4. De wiekendrager 12 is gekoppeld aan de buiten-
ring van het hoofdlager 11. In deze uitvoering is de ge-
20 nerator uitgevoerd met de rotor binnen de stator. Aan de
buitenring van het hoofdlager 11 is een rotorsteunring 67
bevestigd. Om de rotorsteunring 67 is een generatorbin-
nenring 66 bevestigd. Op de generatorbinnenring 66 zijn
rotorpolen 64 bevestigd. De rotorpolen 64 zijn in dit ge-
25 val uitgevoerd als permanente magneten. Ter plaatse van
de bevestiging van de conische bus 5 aan de gondel 4 is
ook een generatorachterwand 65 aan de gondel 4 bevestigd.
De generatorachterwand 65 steunt een generatorbuitenring
61. Aan de voorzijde is de generatorbuitenring 61 voor-
30 zien van een generatorvoorwand 60, die aansluit op de
wiekendrager 12. Tussen de stilstaande generatorvoorwand
60 en de roterende wiekendrager 12 is een afdichting 68
geplaatst. De generatorvoorwand 60, de generatorbuiten-
ring 61 en de generatorachterwand 65 vormen met de con-

sche bus 5 een gesloten ruimte, de generatorruimte 46. De
afdichting 68 is zodanig uitgevoerd dat er geen buiten-
lucht naar binnen kan komen, zodat de lucht in de genera-
torruimte 46 op de hiervoor omschreven wijze gedroogd kan
5 worden en op een kleine overdruk gehouden kan worden. De
afdichting 68 is vanuit de generatorruimte 46 toeganke-
lijk, zodat daar op eenvoudige wijze onderhoud aan ge-
pleegd kan worden.

Aan de binnenzijde van de generatorbuitenring 61
10 zijn statorpolen 63 aangebracht. Voor afvoer van de in de
generatorpolen 63 opgewekte warmte zijn aan de buitenzij-
de van de generatorbuitenring 61 koelribben 62 aange-
bracht. Teneinde er voor zorg te dragen dat de statorpo-
len 63 rondom dezelfde temperatuur hebben zijn de stator-
15 polen 63 op hiervoor omschreven wijze voorzien van een
vloeistof circulatiesysteem. Dit vloeistof circulatiesys-
teem kan permanent ingeschakeld zijn, of alleen als tem-
peratuurverschillen tussen de statorpolen 63 worden geme-
ten. Hiermee wordt voorkomen dat de stator rondom een on-
20 gelijke temperatuur zou krijgen, bijvoorbeeld ten gevolge
van instraling van de zon of tengevolge van door stro-
mingsverschillen rondom de gondel 4 veroorzaakte ver-
schillen in warmteafvoer via de koelribben 62.

Conclusies

1. Windmolen voor het opwekken van elektrisch stroom met behulp van een door wieken (10) aangedreven generator (7) voorzien van een rotor (8), een stator (9) en een
5 lager (11) waarop ook de wieken gelagerd zijn **met het kenmerk dat** de stator is geplaatst in een gesloten ruimte (46) met tenminste een luchtafdichting (26; 68) tussen roterende delen en stationaire delen van de generator.
- 10 2. Windmolen overeenkomstig conclusie 1 **met het kenmerk dat** de gesloten ruimte (46) is voorzien van middelen (51) voor het drogen van in de gesloten ruimte aanwezige lucht.
- 15 3. Windmolen overeenkomstig conclusie 1 of 2 **met het kenmerk dat** de gesloten ruimte (46) is voorzien van middelen (51) voor het toevoeren van gedroogde of droge lucht en eventueel voor het onder een overdruk houden van de gesloten ruimte.
- 20 4. Windmolen overeenkomstig conclusie 2 of 3 **met het kenmerk dat** schakelmiddelen voorzien zijn voor het inschakelen van de middelen (51) voor het drogen van in de gesloten ruimte aanwezige lucht tijdens stilstand van de windmolen.
- 25 5. Windmolen overeenkomstig een der conclusies 1 - 4 **met het kenmerk dat** middelen voorzien zijn voor het rondom op een min of meer gelijke temperatuur houden van de stator (9).
- 30 6. Windmolen overeenkomstig een der conclusies 1 - 5 **met het kenmerk dat** het lager (11) voorzien is van afdichtingen (45) voor het luchtdicht afdichten van de gesloten ruimte en de afdichtingen eventueel geschikt

zijn voor het weerstaan van in de gesloten ruimte aanwezige overdruk.

7. Windmolen overeenkomstig conclusie 6 **met het kenmerk**
dat het lager voorzien is van een smeermiddel toevoer
5 en van een smeermiddel afvoer met kanalen (37,40) die
zodanig aangebracht zijn dat smeermiddel uit het lager
vloeit als daarvan tenminste een gewenste hoeveelheid
in het lager aanwezig is.
8. Windmolen overeenkomstig conclusie 7 **met het kenmerk**
10 **dat** middelen (39) aanwezig zijn voor het controleren
van een smeermiddel circulatie naar het lager (11)
en/of voor het detecteren van een retourstroom van
smeermiddel uit het lager.

Uittreksel

De uitvinding betreft een windmolen voor het opwekken van elektrische stroom met behulp van een door wieken aangedreven generator. De rotor en de wieken zijn gelagerd door een gemeenschappelijk lager. Overeenkomstig de
5 uitvinding is de stator geplaatst in een gesloten ruimte met een luchtafdichting tussen het roterend deel en het stationaire deel van de generator.

INTERNATIONAL SEARCH REPORT

Intern al Application No

PCT/NL 00/00686

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F03D9/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F03D H02K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	DE 44 02 184 A (KLINGER FRIEDRICH PROF DR ING) 3 August 1995 (1995-08-03) cited in the application the whole document	1
Y	US 5 670 838 A (EVERTON JOHN M) 23 September 1997 (1997-09-23) column 4, line 62 -column 6, line 45; figure 1	1
X	PATENT ABSTRACTS OF JAPAN vol. 2000, no. 01, 31 January 2000 (2000-01-31) -& JP 11 299197 A (SUIDEN CO LTD), 29 October 1999 (1999-10-29) abstract; figures 1,2	1

☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

* Special categories of cited documents:

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- *X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- *S* document member of the same patent family

Date of the actual completion of the international search

22 December 2000

Date of mailing of the international search report

03/01/2001

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040. Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Ingelbrecht, P

INTERNATIONAL SEARCH REPORT

Intern: al Application No
PCT/NL 00/00686

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 198 01 803 A (SIEMENS AG) 29 April 1999 (1999-04-29) figure 2	1
X	US 5 814 914 A (CAAMANO RAMON A) 29 September 1998 (1998-09-29) column 8, line 32 -column 9, line 16; figure 1 the whole document	1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/NL 00/00686

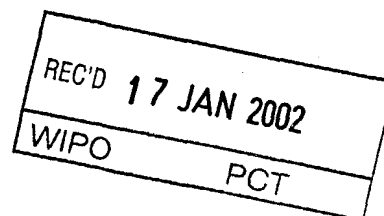
Patent document cited in search report		Publication date	Patent family member(s)	Publication date
DE 4402184	A	03-08-1995	NONE	
US 5670838	A	23-09-1997	AT 144658 T	15-11-1996
			AU 671799 B	12-09-1996
			AU 1870792 A	08-01-1993
			DE 69214812 D	28-11-1996
			DE 69214812 T	15-05-1997
			EP 0587812 A	23-03-1994
			WO 9222121 A	10-12-1992
			GB 2271673 A	20-04-1994
			JP 6507780 T	01-09-1994
JP 11299197	A	29-10-1999	NONE	
DE 19801803	A	29-04-1999	NONE	
US 5814914	A	29-09-1998	US 5731649 A	24-03-1998
			US 5903082 A	11-05-1999
			US 5986378 A	16-11-1999
			US 6049197 A	11-04-2000
			US 6154013 A	28-11-2000
			US 5982070 A	09-11-1999

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT



(PCT Article 36 and Rule 70)



3

Applicant's or agent's file reference 1011 WO 1	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/NL00/00686	International filing date (day/month/year) 25/09/2000	Priority date (day/month/year) 24/09/1999
International Patent Classification (IPC) or national classification and IPC F03D9/00		
Applicant LAGERWEY WINDTURBINE B.V. et al		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 4 sheets, including this cover sheet. <input type="checkbox"/> This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT). These annexes consist of a total of sheets.
3. This report contains indications relating to the following items: I <input checked="" type="checkbox"/> Basis of the report II <input type="checkbox"/> Priority III <input type="checkbox"/> Non-establishment of opinion with regard to novelty, inventive step and industrial applicability IV <input type="checkbox"/> Lack of unity of invention V <input checked="" type="checkbox"/> Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement VI <input type="checkbox"/> Certain documents cited VII <input checked="" type="checkbox"/> Certain defects in the international application VIII <input type="checkbox"/> Certain observations on the international application

Date of submission of the demand 12/04/2001	Date of completion of this report 14.01.2002
Name and mailing address of the International preliminary examining authority;  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Poock, M Telephone No. +49 89 2399 2461 

Form PCT/IPEA/409 (cover sheet) (January 1994)

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/NL00/00686

I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17):*)

Description, pages:

1-11 as originally filed

Claims, No.:

1-8 as originally filed

Drawings, sheets:

1/6-6/6 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/NL00/00686

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	
	No: Claims	1-8
Inventive step (IS)	Yes: Claims	
	No: Claims	1-8
Industrial applicability (IA)	Yes: Claims	1-8
	No: Claims	

2. Citations and explanations
see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:
see separate sheet

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/NL00/00686

1. DE-A-19 802 803 (D1) discloses a windmill (cf Fig 2) for generating electric current with the aid of a generator which is driven by vanes 18 and is provided with a rotor 4, a stator 6, 7 and a bearing (disclosed implicitly to a skilled person) on which the vanes are also mounted. The stator 6, 7 is positioned in a closed chamber 3 (can be seen in Fig 2) with at least one air seal (disclosed implicitly to a skilled person) between rotating parts and stationary parts of the generator.

These features are also known from DE-A-4 402 184 (D2).

The subject-matter of claim 1 as such was therefore already known. By consequence, the subject-matter of claim 1 does not meet the requirements of Article 33 (2) EPC.

2. It should be noted that the characterising features of claim 1 are also known from documents US-A-5 670 838 (D3) and US-A-5 814 914 (D4).

In view of the advantages achieved by these generators, it is obvious for the skilled person to combine the teaching of these documents with known windmills and to thus arrive at the solution proposed in claim 1.

Therefore, the subject-matter of claim 1 is not considered as involving an inventive step (Article 33(3) PCT).

3. Dependent claims 2-8 propose features which appear of being already known in the state of the art as cited in the search report or of being matters of normal design procedure for the skilled person. Thus, these claims do not appear to contain any additional features which, in combination with the features of any claim to which they refer, could form subject matter which is new and involves an inventive step.
4. Contrary to the requirements of Rule 5.1(a)(ii), (iii) PCT, the relevant background art disclosed in the documents mentioned in the search report are not mentioned in the description, nor are these documents identified therein, nor is the description consistent with the claims.

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 1011 WO 1	FOR FURTHER ACTION see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. PCT/NL 00/ 00686	International filing date (day/month/year) 25/09/2000	(Earliest) Priority Date (day/month/year) 24/09/1999
Applicant LAGERWEY WINDTURBINE B.V.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 3 sheets.



It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

- a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.



the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

- b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :



contained in the international application in written form.



filed together with the international application in computer readable form.



furnished subsequently to this Authority in written form.



furnished subsequently to this Authority in computer readable form.



the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.



the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ **Certain claims were found unsearchable** (See Box I).

3. ☐ **Unity of invention is lacking** (see Box II).

4. With regard to the **title**,



the text is approved as submitted by the applicant.



the text has been established by this Authority to read as follows:

WIND POWER GENERATOR

5. With regard to the **abstract**,



the text is approved as submitted by the applicant.



the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No.



as suggested by the applicant.



because the applicant failed to suggest a figure.



because this figure better characterizes the invention.

1



None of the figures.

INTERNATIONAL SEARCH REPORT

International Application No

NL 00/00686

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F03D9/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 F03D H02K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	DE 44 02 184 A (KLINGER FRIEDRICH PROF DR ING) 3 August 1995 (1995-08-03) cited in the application the whole document	1
Y	US 5 670 838 A (EVERTON JOHN M) 23 September 1997 (1997-09-23) column 4, line 62 -column 6, line 45; figure 1	1
X	PATENT ABSTRACTS OF JAPAN vol. 2000, no. 01, 31 January 2000 (2000-01-31) -& JP 11 299197 A (SUIDEN CO LTD), 29 October 1999 (1999-10-29) abstract; figures 1,2	1
	--- -/--	

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents:

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

T later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

X document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

& document member of the same patent family

Date of the actual completion of the international search

22 December 2000

Date of mailing of the international search report

03/01/2001

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Ingelbrecht, P

INTERNATIONAL SEARCH REPORT

International Application No

P/NL 00/00686

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 198 01 803 A (SIEMENS AG) 29 April 1999 (1999-04-29) figure 2	1
X	US 5 814 914 A (CAAMANO RAMON A) 29 September 1998 (1998-09-29) column 8, line 32 -column 9, line 16; figure 1 the whole document	1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

P/NL 00/00686

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
DE 4402184	A	03-08-1995	NONE	
US 5670838	A	23-09-1997	AT 144658 T	15-11-1996
			AU 671799 B	12-09-1996
			AU 1870792 A	08-01-1993
			DE 69214812 D	28-11-1996
			DE 69214812 T	15-05-1997
			EP 0587812 A	23-03-1994
			WO 9222121 A	10-12-1992
			GB 2271673 A	20-04-1994
			JP 6507780 T	01-09-1994
JP 11299197	A	29-10-1999	NONE	
DE 19801803	A	29-04-1999	NONE	
US 5814914	A	29-09-1998	US 5731649 A	24-03-1998
			US 5903082 A	11-05-1999
			US 5986378 A	16-11-1999
			US 6049197 A	11-04-2000
			US 6154013 A	28-11-2000
			US 5982070 A	09-11-1999

WIND POWER GENERATOR

The invention relates to a windmill according to the preamble of Claim 1. A windmill of this type is known from DE 4402184. In the known device, it is possible that moisture may be deposited on the windings of the generator while the windmill is at a standstill. In this case, before the windmill can be started up, the stator has to be heated in order to expel the moisture, since otherwise a short circuit may occur in the windings of the stator. This heating takes up considerable time, which consequently has an adverse effect on the time for which the windmill can be used to good effect. To avoid this drawback, the device is designed in accordance with the preamble of Claim 1. This prevents moist air from being fed into the chamber around the stator, thus avoiding the deposition of moisture.

According to a refinement, the invention is designed in accordance with Claim 2. This further reduces the risk of condensation on the stator.

According to a refinement, the device is designed in accordance with Claim 3. This prevents moist air from being fed into the closed chamber.

According to a refinement, the device is designed in accordance with Claim 4. As a result, the air is dried only when there is a risk of condensation, so that the wear to the air dryer is limited.

According to a refinement, the device is designed in accordance with Claim 5. This ensures that the stator is at a uniform temperature all the way around and there is no possibility of local condensation. The stator is also prevented from becoming unround, so that the air gap can be kept smaller.

According to one embodiment, the windmill is designed in accordance with Claim 6. As a result, it is impossible for any air to be supplied or discharged along the bearing and, if appropriate, a

- 2 -

superatmospheric pressure may be applied in the closed chamber.

According to one embodiment, the windmill is designed in accordance with Claim 7. This makes it easier to check the presence of lubricant in the bearing, so that there is no damage caused to the seals as a result of absence of lubricant.

According to a refinement, the device is designed in accordance with Claim 8. As a result, it is easily possible to check on an ongoing basis that the bearing and the seals are being lubricated correctly and, if necessary, to institute appropriate measures.

The invention is explained below with reference to an exemplary embodiment and with the aid of a drawing, in which:

- Figure 1 shows a diagrammatic cross section through a windmill,
- Figure 2 shows a cross section and partial view of a part of the windmill shown in Figure 1,
- Figure 3 shows a cross section through the generator of the windmill shown in Figure 1,
- Figure 4 shows a longitudinal section through the generator of the windmill shown in Figure 1,
- Figure 5 diagrammatically depicts the lubrication unit of the bearing of the windmill shown in Figure 1,
- Figure 6 diagrammatically depicts the cooling unit of the generator of the windmill shown in Figure 1,
- Figure 7 diagrammatically depicts the supply of air to the generator chamber of the windmill shown in Figure 1,
- Figure 8 shows a second embodiment of the air channel of the cooling unit, and
- Figure 9 shows a second embodiment of the generator of the windmill shown in Figure 1.

Figure 1 shows a cross section through a machine housing 4 of a windmill. The machine housing 4

- 3 -

is positioned on a mast 1 by means of a bearing 2. The machine housing 4 comprises a generator 7 which is mounted around a conical bush 5. On the conical bush 5 are mounted a stator 9 and a main bearing 11 which can rotate about an axis of rotation 3. A rotor 8, which is arranged on the outside of the stator 9, is attached to the rotating part of the main bearing 11. The outer circumference of the generator 7 is covered by a generator cap 6 which rotates with the rotor 8, thus forming a generator chamber 46.

A vane support 12, to which three vanes 10 are attached, is likewise attached to the rotating part of the main bearing 11, which vanes 10 are provided with a vane adjustment mechanism (not shown). To provide current to the rotor 8 and the vane adjustment mechanisms, there is a slip ring holder 14 with slip rings. The front side of the vane support 12 is protected by a nose cap 13.

A platform 15 is arranged inside the machine housing 4 at the location of the conical bush 5, for operating staff. The machine housing 4 also accommodates an air unit 16, a cooling unit 17 and a lubrication unit 18. The air unit 16 is responsible for feeding air to the generator chamber 46, this air preferably being dried in order to prevent moisture from reaching the windings of the generator 7.

In a manner which is to be indicated in more detail, the cooling unit 17 ensures that cooling liquid is circulated through the stator 9 of the generator, with the result that heat is dissipated from the generator 7. Considerable amounts of heat are developed in the stator 9 of the generator, which heat has to be dissipated immediately. To this end, the cooling unit 17 accommodates a heat exchanger 49 which is held in an air channel 56. The air channel 56 runs from a cooling-air inlet 54, which is arranged on the windward side of the machine housing 4, to a cooling-air outlet 57, which is positioned on the leeward side of the machine housing 4. The air channel 56 is a more or less closed

- 4 -

channel, so that the cooling air, which may be salty and moist, does not enter the machine housing 4. If appropriate, the air channel 56 accommodates a fan 55, so that the dimensions of the air channel 56 and the heat exchanger 49 can be kept smaller while retaining the same cooling capacity. If appropriate, heat can be fed to the circulating cooling liquid during or after a prolonged standstill period, for example, as a result of the absence of wind, in order to keep warm or heat the windings of the stator 9, so that condensation is not formed or disappears.

The lubrication unit 18 ensures that the main bearing 11 is suitably lubricated. Moreover, the machine housing 4 contains various control and safety units which are not described in more detail, for example for controlling the adjustment of the vanes and for controlling the abovementioned units. Additionally, there is a brake (not shown) and, if appropriate, a blocking pin for stopping movement of the vanes 10 of the windmill during maintenance work.

In the exemplary embodiment of the windmill which is shown, the mast 1 is approximately 70 metres high and has a diameter of 2 metres. The diameter of the vanes 10 is 70 metres, the diameter of the main bearing 11 is approximately 1800 millimetres and the diameter of the generator is 3800 millimetres. The rated output generated by the generator 9 is 1500 kilowatts at a rotational speed of the rotor of 18 revolutions per minute and 2000 kilowatts at 24 revolutions per minute.

Figure 2 shows the generator 7. The bottom half of the figure shows the stator 9 in cross section. A support ring 22 with support plates 21 is secured around the conical bush 5. A stator core 23, which is composed in a known way of plates of soft iron, is secured around the support ring 22. In the outer circumference of the stator core 23, there are winding slots 30 between stator poles 19, cf. Figure 1, through which the windings of a stator coil 20 run. The top

- 5 -

half of the figure shows a view of the outside of the stator coil 20, from which it can be seen that the stator poles 19 form an angle of approximately 5 degrees with the axis of rotation 3. On account of
5 this angle, the stator poles 19 also form an angle with the magnets of the rotor 8 which are positioned parallel to the axis of rotation 3. This results in the generator running quietly.

Figures 3 and 4 show a more detailed view of
10 the generator 7, Figure 3 showing the cross sections IIIA and IIIB from Figure 4, and Figure 4 showing the cross section IVA and the view IVB from Figure 3. The stator core 23 is arranged around the support ring 22, the stator core 23 being provided with stator poles 19
15 and winding slots 30 between them. The windings running through the winding slots 30 together form the stator coil 20. The stator core 23 is composed of plates which are clamped between clamping plates 29 by tension rods 34. Cooling lines 29 run through the stator core 23,
20 and are connected to an inlet line 24 and an outlet line via a manifold.

Magnet cores 33 are attached to the generator cap 6 in a known way. Around each magnet core 33 there is a coil 31 which, during use, is energised in a known
25 way by a field current, so that when the rotor 8 rotates, changing magnetic fields are generated in an air gap 32 between the stator poles 19 and the magnet cores 33, with the result that electric voltage and an electric current is generated in the stator coil 20.
30 Partly as a result of the electric current generated in the windings, heat is developed in the stator 9, and this heat has to be dissipated. The temperature in the windings is measured using a temperature sensor 44. If the temperature is too high, for example if it reaches
35 above 40° Celsius, the cooling unit 17 is switched on. The cooling unit 17 is provided, for example, with a controller for keeping the temperature of the stator at a constant level. As a result, the temperature of the stator coil 20 remains low, with the result that the

- 6 -

resistance in the wires of the windings does not increase and there is no adverse effect on the efficiency. The heat which is generated in the rotating magnet coils 31 and the magnet core 33 is dissipated via the magnet core 33 to the generator cap 6 and, from there, to atmosphere. Partly as a result of the temperature in the stator 9 being held at 40° Celsius, the temperature of the space enclosed by the stator also does not become any warmer, and the temperature of the equipment inside the machine housing 4 and of the main bearing 11 remains sufficiently low, so that there is no need to provide any additional cooling for these components.

Once the wind has stopped, there is a risk of moisture condensing on the windings of the stator coil 20. When the generator is started up, a high voltage is applied to the stator coil 20, and there is then a risk of short-circuiting in the windings, causing a fault in the installation. To reduce this risk, the deposition of moisture is prevented or moisture which has been deposited is expelled by heating as a result of the stator coil 20 being heated before it is started up. This heating may use special windings in the coil, which function as electric heater means. Another embodiment is for the stator coil 20 to be heated using the liquid in the cooling line 28. As a result of the stator coil 20 being heated uniformly all the way around, there is no possibility of local cold spots at which condensation may form.

The rotor has coils 31 which are easy to heat electrically as a result of current being passed through the coils 31, generation of current in the stator 9 being prevented by, for example, energizing the coils 31 with AC current.

An additional advantage of the uniform heating of the stator 9 and of the stator 9 being held at a constant temperature is that it maintains the same temperature all the way around and therefore expands uniformly and to a limited extent all the way around as

- 7 -

a result of the temperature being controlled within tight limits. As a result, the air gap 32 will remain the same all the way around and does not become too small in certain areas through local expansion. As a result, the air gap 32 can be kept small, which has a beneficial effect on the efficiency of the generator 7.

The risk of condensation on the stator coil 20 is reduced further by ensuring that the generator chamber 46 contains only dry air, which is useful in particular if the windmill is positioned, for example, near or in the sea. For this purpose, the main bearing 11 is provided in a known way with seals 45, and a seal 26 is positioned between the rotating generator cap 6 and the stationary conical ring 5, and all other openings in the generator chamber 46 are sealed. The seal 26 is provided with a dust cap 27, so that the rubber of the seal is protected from the effects of sun and other influences from the weather. To prevent air from being drawn into generator chamber 46 from the outside in the event of temperature changes, the air unit 16 provides a possibly limited superatmospheric pressure in the generator chamber 46 by supplying air from the machine housing 4, which air is as dry as possible and is preferably dried even further using an air dryer. If appropriate, the air unit 16 is designed in such a manner that air is sucked out of the generator chamber 46. This air is then mixed in the air unit 16 with a limited amount of air from the outside or from out of the machine housing 4 and is then dried and returned to the generator chamber 46. If appropriate, the air unit 16 is provided with switching means, so that the air unit is only switched on when the windmill is at a standstill. Since the stator is sufficiently warm while the windmill is operating, there is then no risk of condensation, and consequently wear to the air unit is reduced. It is also possible for sensors (not shown) to be arranged in the generator chamber 46, which can be used to measure the dew point of the air. If the air approaches the dew point, for

- 8 -

example as a result of cooling, the air unit 16 switches on, so that condensation is prevented.

The exemplary embodiment describes a generator 7 in which the air gap 32 is a round cylinder. It is also possible in a similar way to make a generator in which the air gap 32 is conical, so that the generator 7 better follows the shape of the conical bush 5, and, if appropriate, weight may be saved. The generator 7 illustrated is designed with forty-eight stator poles 19 and forty-eight magnet coils 31. Naturally, the generator may also be designed differently, for example with permanent magnets instead of the rotor 8 shown here, in which case features may be provided in the form of, for example, a displaceable stainless steel bush for interrupting the magnetic field lines when the windmill is switched off.

For the windmill to operate without problems, it is important that the main bearing 11 should be continuously provided with lubricant. For this purpose, a lubrication unit 18 is available, the action of which is shown in Figure 5. The main bearing 11 has an outer ring 41, an inner ring 43, a race 42 and seals 45 (cf. Figure 3). In the top of the main bearing 11, a feed line 40 opens out into the race 42, and half-way between the bottom and the centre of the main bearing 11 there is a return line 37 connected to the race 42. A pump 36 is used to pump oil out of a buffer vessel 35 into the feed line 40, a pressure and/or flow rate sensor 39 being used to monitor whether oil is being pumped. Oil which has been pumped into the race 42 flows back into the buffer vessel 35. If insufficient oil returns to the buffer vessel 35, for example as a result of a leak in the seal 45, the level falls. This is signalled using a level sensor 38, so that maintenance can be carried out in good time. The main bearing 11 in the meantime retains sufficient oil because there is still oil in the bottom of the race 42. If appropriate, a sensor is arranged in the

- 9 -

bearing, which detects when the bearing warms up, after which the windmill is stopped.

Figure 6 diagrammatically depicts the system for controlling the temperature of the stator 9, known components of a circulation system of this type, including a liquid reservoir, sensors, thermostatic valves, shut-off valves and other control means not being shown in this figure. Since this system is essential for the generation of electricity, where necessary the various components are in duplicate, so that the windmill is prevented from shutting down if a component fails. By means of a circulation pump 47, liquid is pumped through the feed line 24 and the manifold 25 to the cooling lines 28. The liquid emerging from the stator 9 is passed into a heat exchanger 49 where it is cooled by air circulation. The heat exchanger 49 is positioned in the closed air channel 56 through which outside air can flow. The flow of the outside air through the heat exchanger 49 takes place as a result of the wind which blows on to the cooling air outlet 54, if appropriate with the assistance of thermal circulation as a result of heated air rising towards the cooling air outlet 57, which is at a higher level than the cooling air inlet 54. If appropriate, the air channel 56 contains a fan which, for example, is switched on when additional cooling is required. The heat exchanger 49, may for example, also be designed as part of the wall of the machine housing 4, the heat being dissipated by air which flows along the outside. If appropriate, the circulating liquid is heated in a heater arrangement 48, so that the stator 9 can be heated. To provide reliable operation, the circulation pump 47 and the heat exchanger 49 may be provided in duplicate.

The air channel 56 may also be designed differently, as shown in Figure 8. In this case, the air channel 56 is formed by the conical bush 5 and the support ring 22, which is then widened to as far as the front and rear sides of the generator cap 6. In this

- 10 -

case, there is a seal 26 on the rear side and a similar seal 58 on the front side, so that the generator chamber 46 remains closed. Therefore, the heat exchanger 49 is positioned in the space between the conical bush 5 and the support ring 22. On the front side, the generator cap 6 is provided with cooling air inlets 54 and on the rear side there are openings as cooling air outlets 57. Means which are not shown are also provided for discharging the rain which blows into the chamber.

Figure 7 diagrammatically depicts the way in which the means for maintaining a superatmospheric pressure in the generator chamber 46 operates. The generator chamber 46 is more or less airtight and air which is blown in by means of a fan 50 via an air inlet 52 can only emerge via an air outlet 53, which air outlet 53 is situated, for example, at the location of the seal 26. It is preferable to use an air dryer 51, so that the moisture content of the air in the generator chamber 46 remains low. In another embodiment, the air unit 16 is designed in such a manner that the amount of air present in the generator chamber 46 is sucked in by the fan 50 at the same time as a small amount of outside air which is required in order to maintain a superatmospheric pressure in the generator chamber 46. The air which has been sucked in is dried in the air dryer 51 and is introduced into the generator chamber 46.

Figure 9 shows a second embodiment of the generator of the windmill shown in Figure 1. In this case too, the main bearing 11 is coupled to the machine housing 4 by the conical bush 5. The vane support 12 is coupled to the outer ring of the main bearing 11. In this embodiment, the generator is designed with the rotor inside the stator. A rotor support ring 67 is attached to the outer ring of the main bearing 11. A generator inner ring 66 is secured around the rotor support ring 67. Rotor poles 64 are attached to the generator inner ring 66. The rotor poles 64 are in this

- 11 -

case designed as permanent magnets. At the location where the conical bush 5 is attached to the machine housing 4, a generator rear wall 65 is also attached to the machine housing 4. The generator rear wall 65 supports a generator outer ring 61. On the front side, the generator outer ring 61 is provided with a generator front wall 60 which adjoins the vane support 12. A seal 68 is positioned between the stationary generator front wall 60 and the rotating vane support 12. The generator front wall 60, the generator outer ring 61 and the generator rear wall 65, together with the conical bush 5, form a closed chamber, the generator chamber 46. The seal 68 is designed in such a manner that it is impossible for any outside air to enter, so that the air in the generator chamber 46 can be dried in the manner described above and can be kept at a slight superatmospheric pressure. The seal 68 is accessible from the generator chamber 46, so that it is easy to carry out maintenance work thereon.

Stator poles 63 are arranged on the inside of the generator outer ring 61. To dissipate the heat generated in the generator poles 63, cooling ribs 62 are arranged on the outside of the generator outer ring 61. To ensure that the stator poles 63 are at the same temperature all the way around, the stator poles 63 are provided with a liquid circulation system, in the manner described above. This liquid circulation system may be permanently switched on or may be switched on only when temperature differences between the stator poles 63 are measured. This prevents the stator from reaching a temperature which is not uniform all the way around, for example as a result of insolation or as a result of differences in the dissipation of heat via the cooling ribs 62, which are caused by differences in flow around the machine housing 4.

- 12 -

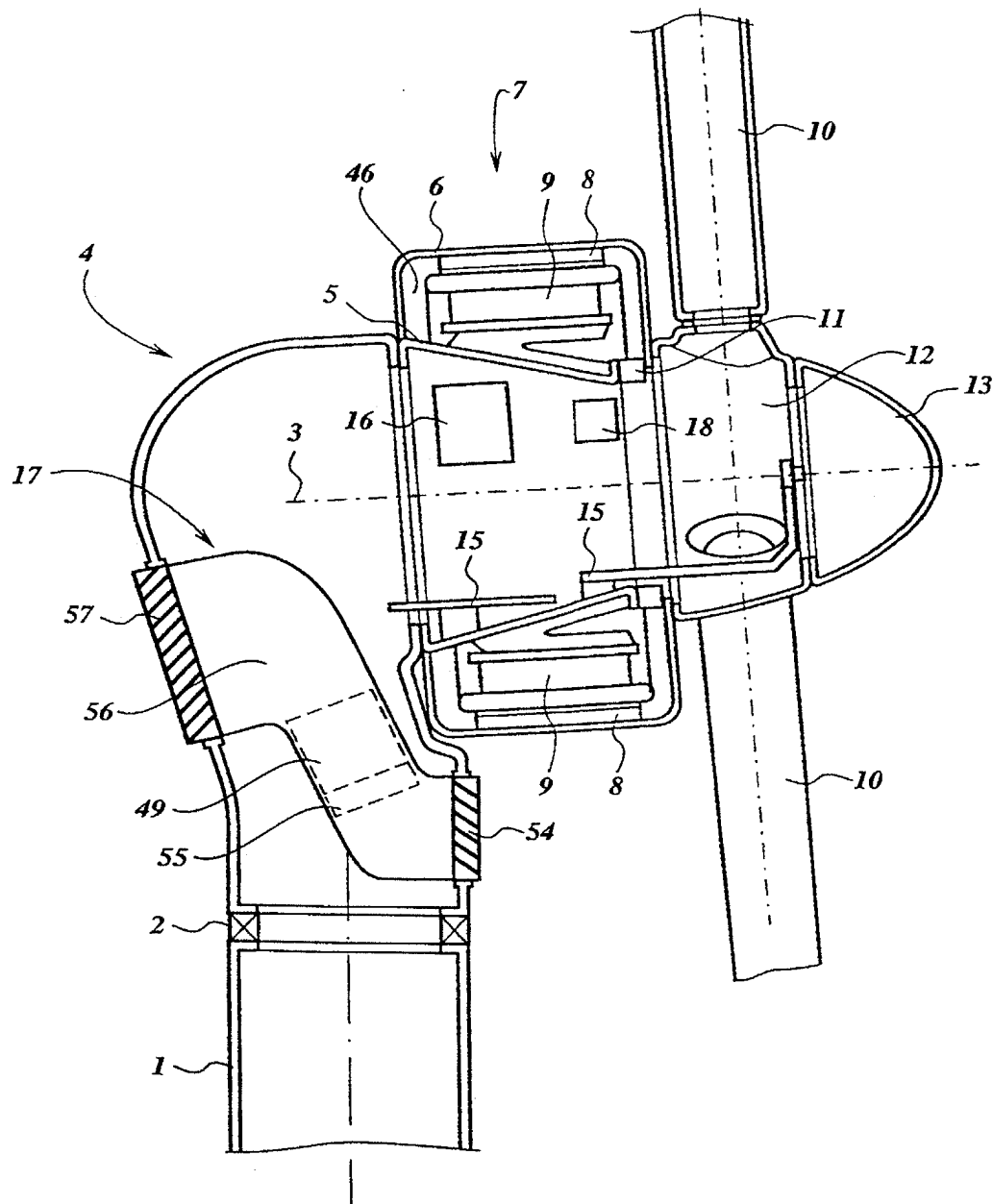
Claims

1. Windmill for generating electric current with the aid of a generator (7) which is driven by vanes (10) and is provided with a rotor (8), a stator (9) and a bearing (11) on which the vanes are also mounted, characterized in that the stator is positioned in a closed chamber (46) with at least one air seal (26; 68) between rotating parts and stationary parts of the generator.
2. Windmill according to Claim 1, characterized in that the closed chamber (46) is provided with means (51) for drying air which is present in the closed chamber.
3. Windmill according to Claim 1 or 2, characterized in that the closed chamber (46) is provided with means (51) for feeding dried or dry air and, if appropriate, for maintaining a superatmospheric pressure in the closed chamber.
4. Windmill according to Claim 2 or 3, characterized in that switching means are provided for switching on the means (51) for drying air which is present in the closed chamber while the windmill is at a standstill.
5. Windmill according to one of Claims 1 - 4, characterized in that means are provided for keeping the stator (9) at more or less the same temperature all the way around.
6. Windmill according to one of Claims 1 - 5, characterized in that the bearing (11) is provided with seals (45) for providing an air-tight seal for the closed chamber, and the seals, if appropriate, are suitable for withstanding the superatmospheric pressure which is present in the closed chamber.
7. Windmill according to Claim 6, characterized in that the bearing is provided with a lubricant inlet and with a lubricant outlet having channels (37, 40) which are arranged in such a manner that lubricant flows out

- 13 -

of the bearing when at least a desired amount of lubricant is present in the bearing.

8. Windmill according to Claim 7, characterized in that there are means (39) for monitoring the
- 5 circulation of lubricant to the bearing (11) and/or for detecting a return flow of lubricant out of the bearing.

*Fig. 1*

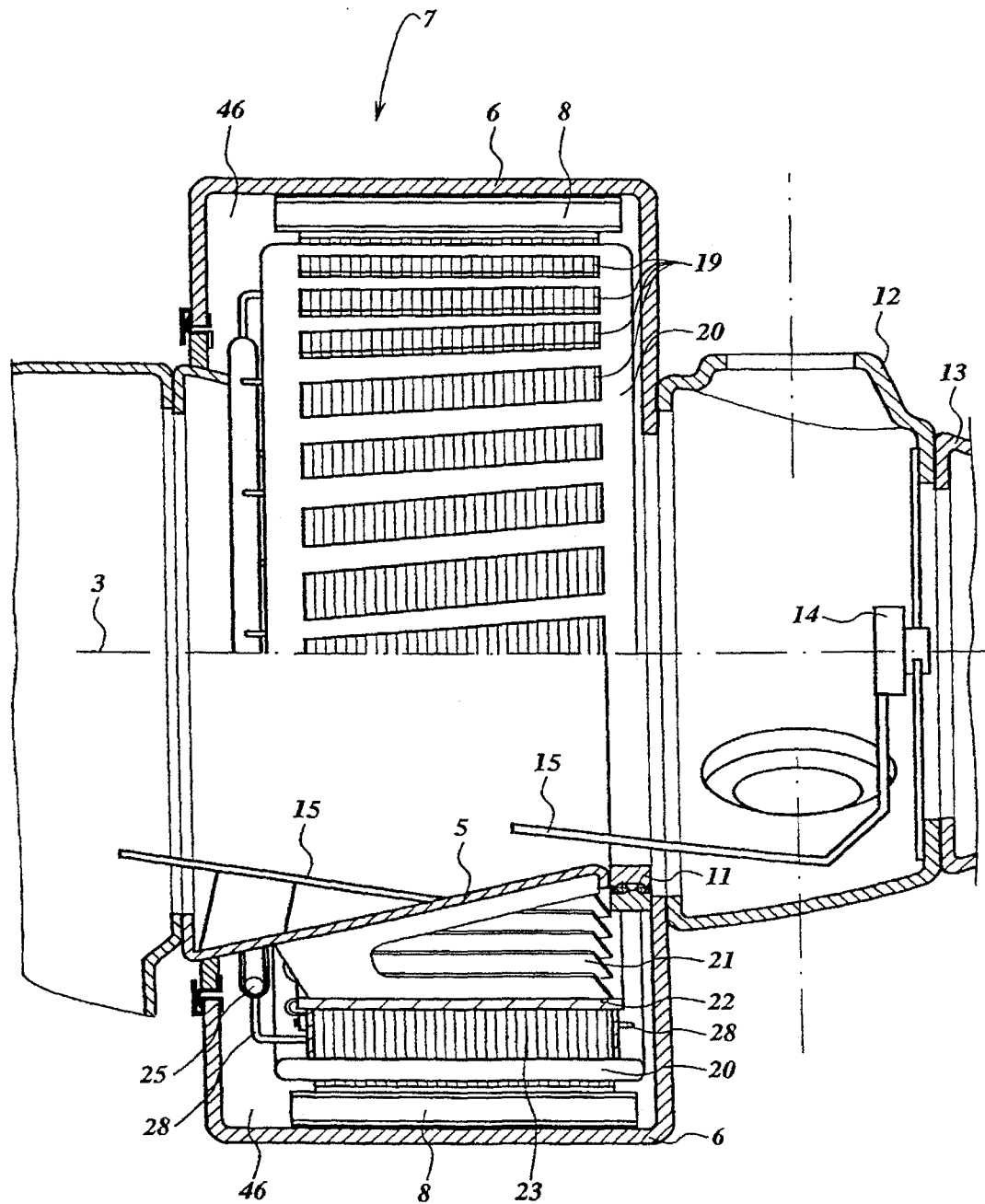
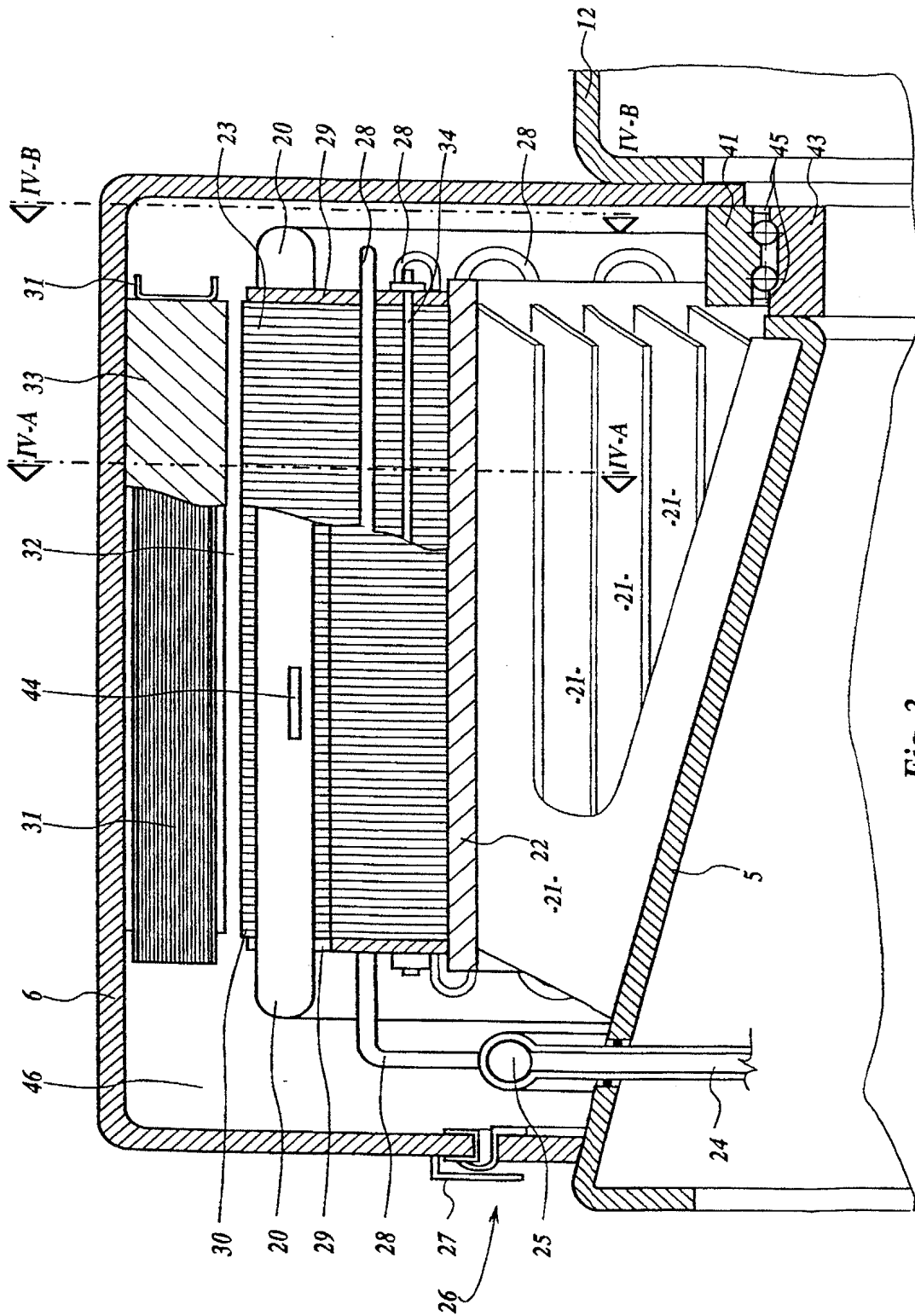


Fig. 2



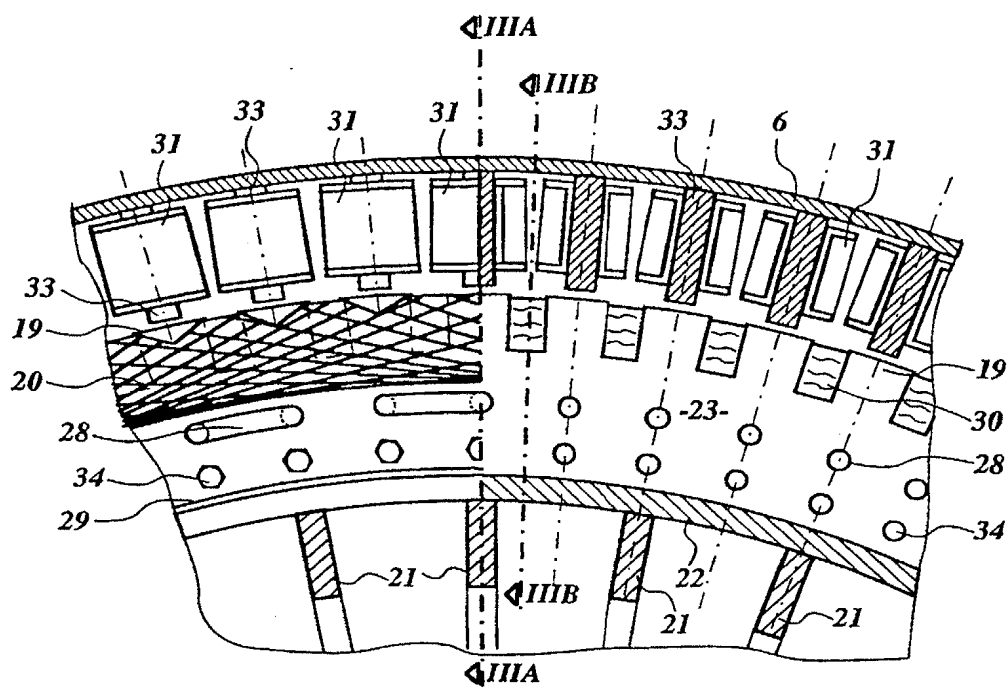


Fig. 4

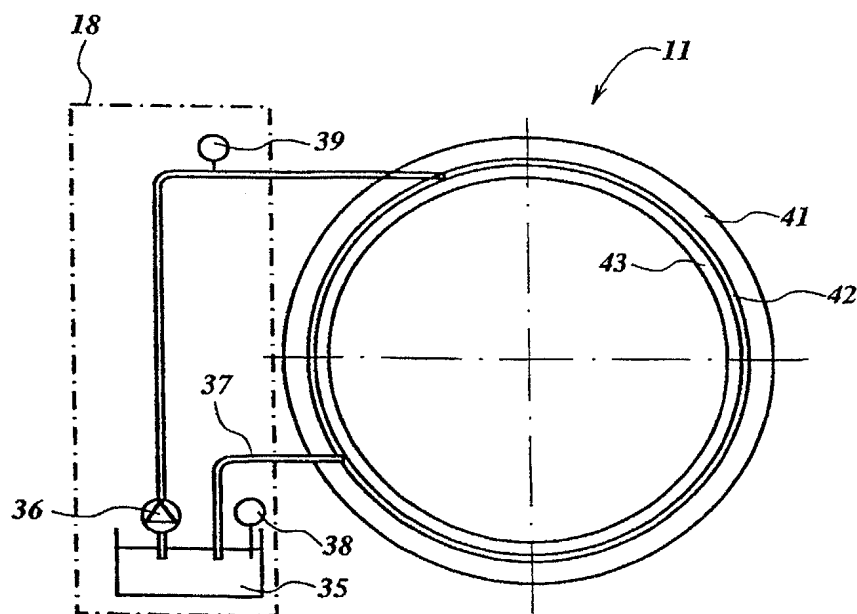


Fig. 5

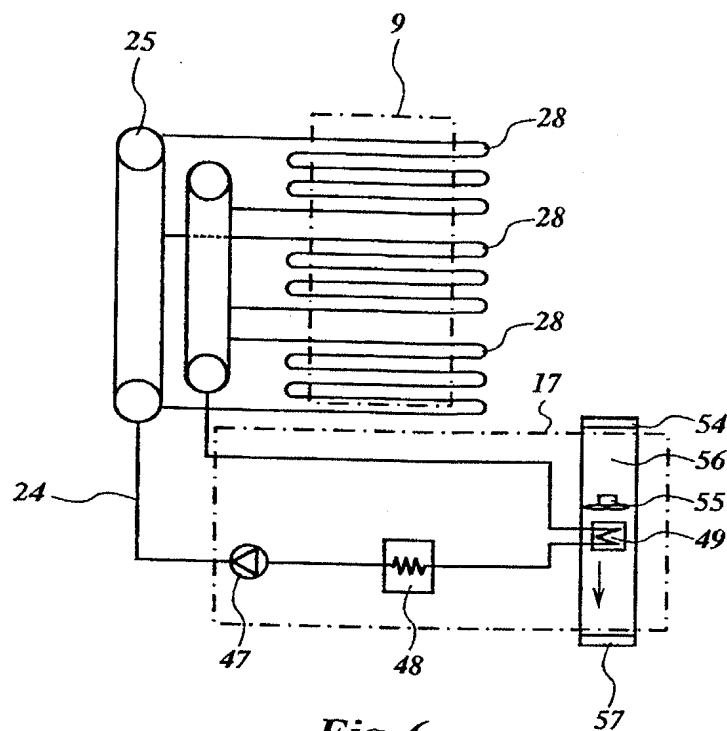


Fig. 6

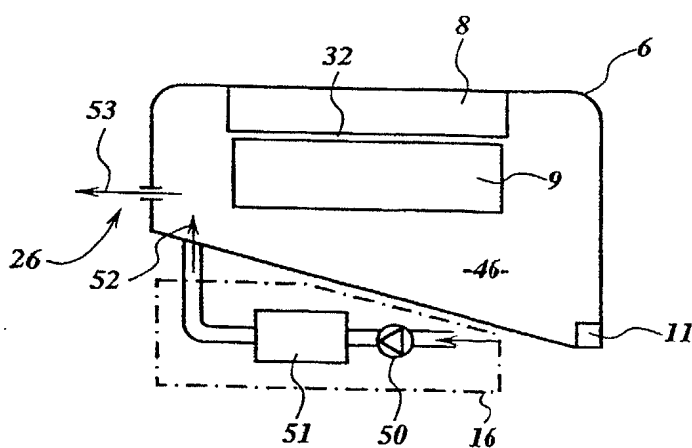


Fig. 7

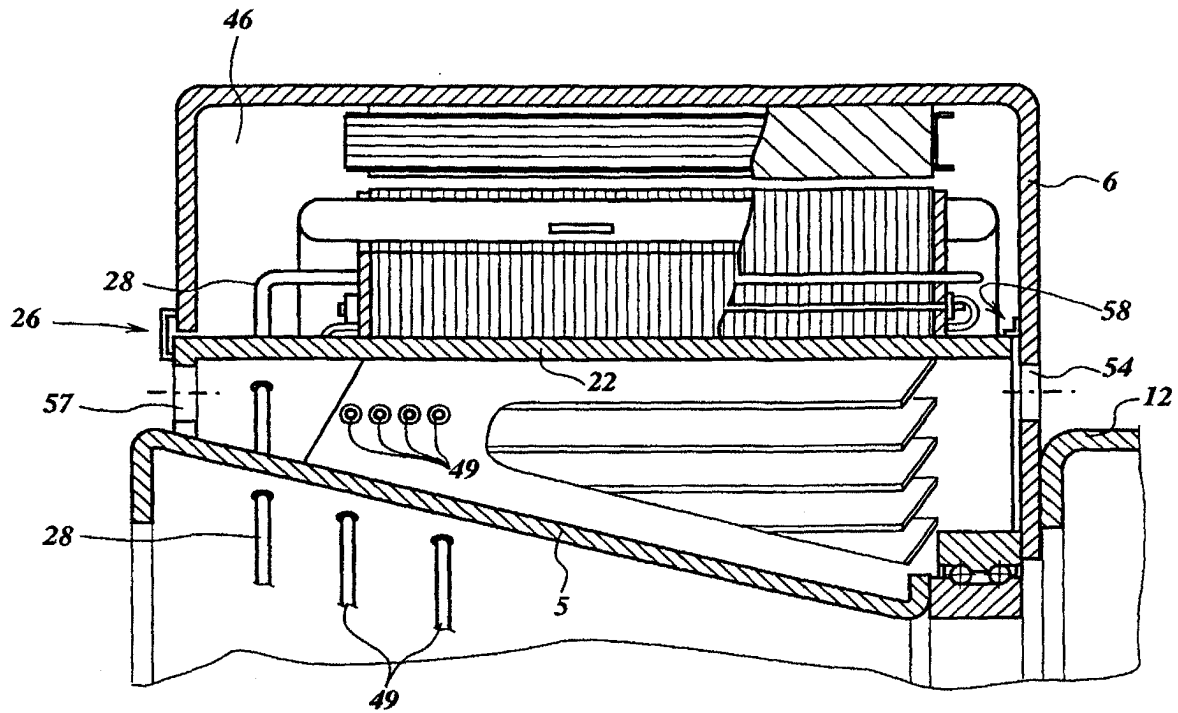


Fig. 8

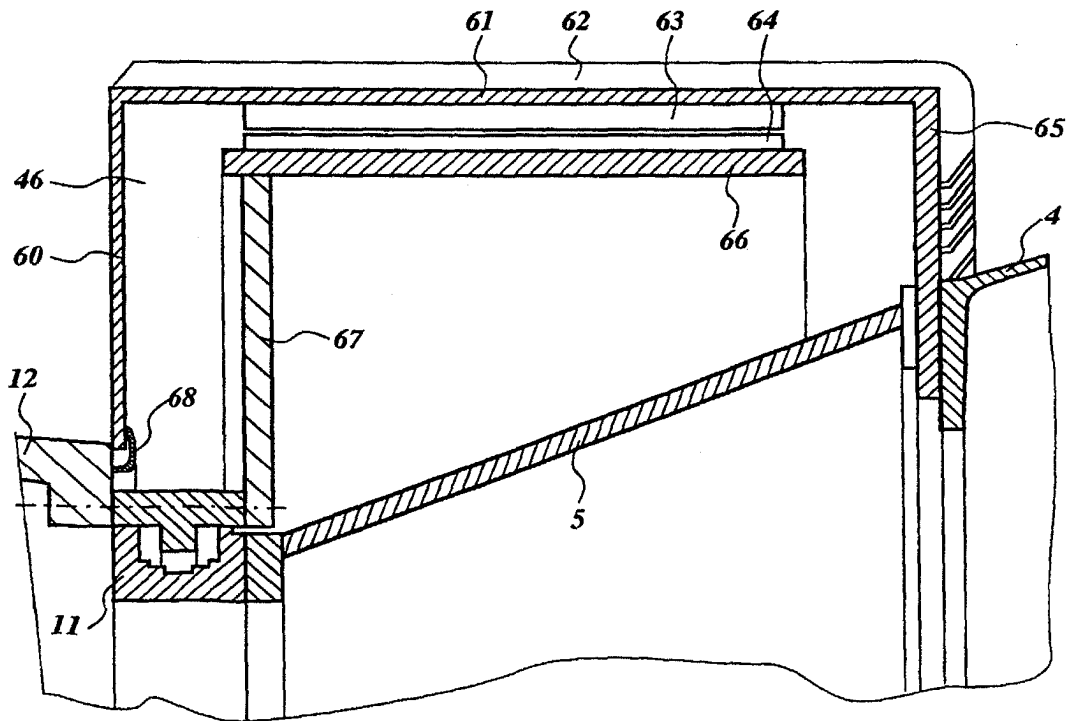


Fig. 9

10 / 088941

WO 01/21956

PCT/NL00/00686

2/6

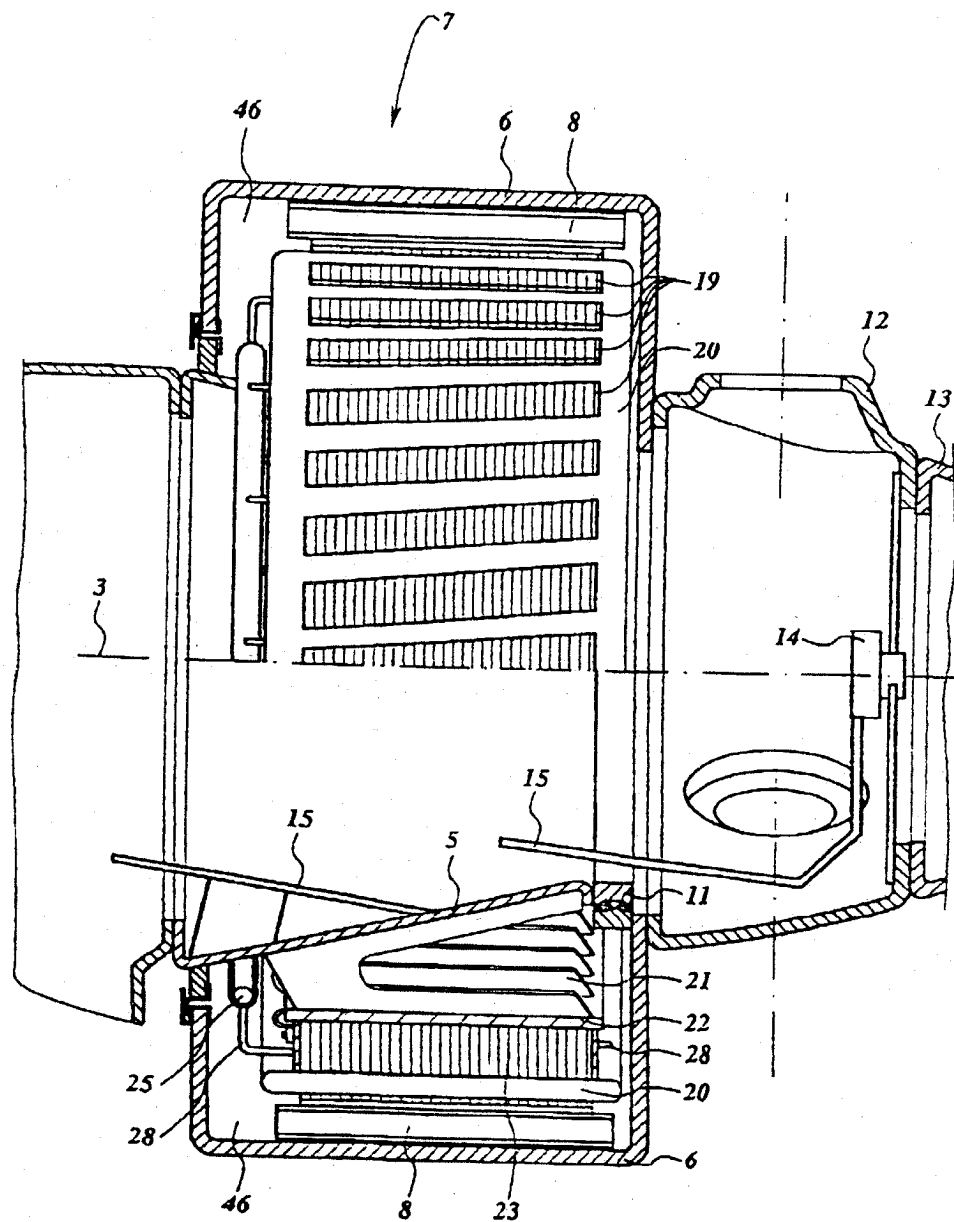
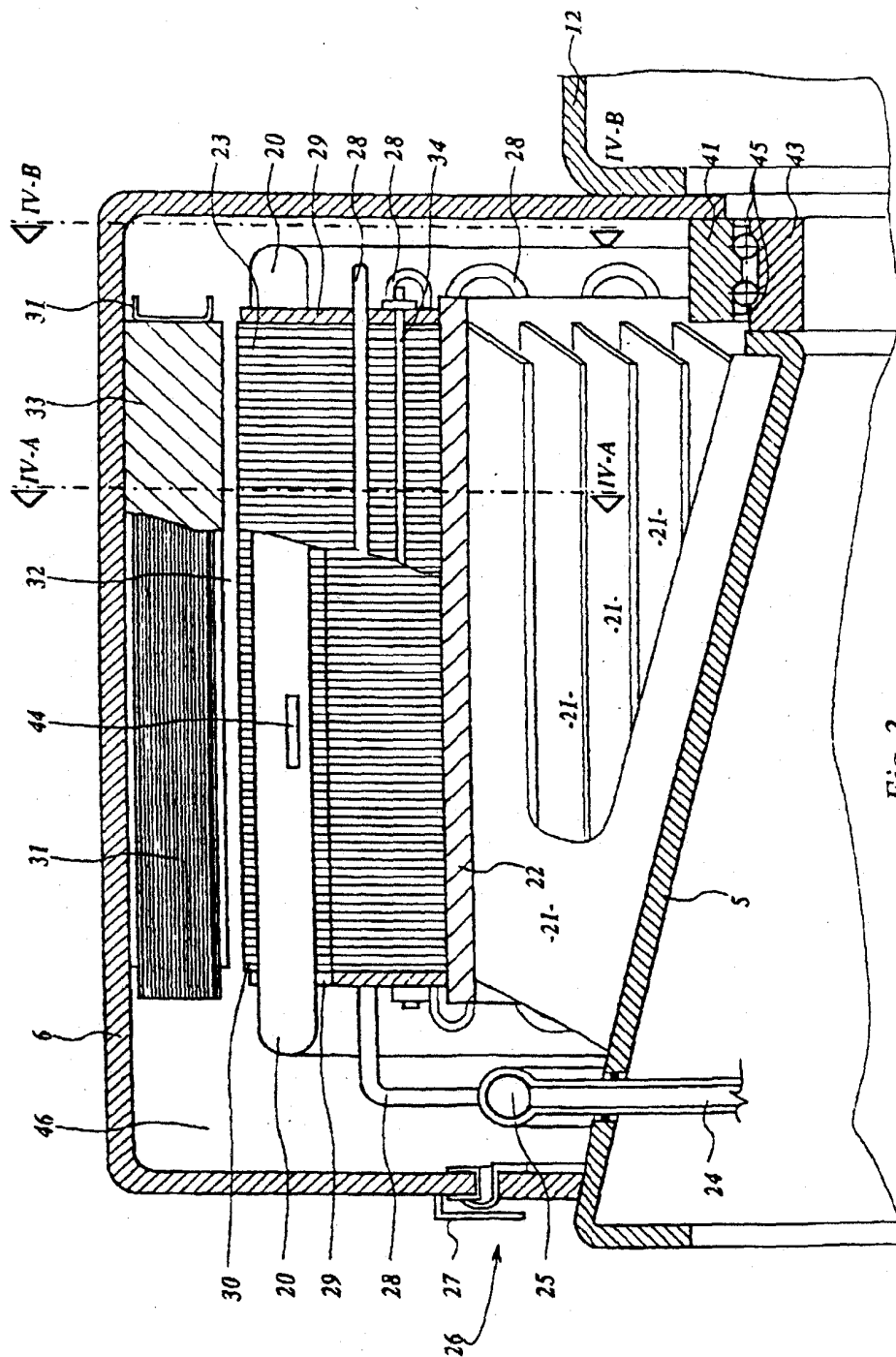


Fig. 2

WO 01/21956

PCT/NL00/00686

3/6



WO 01/21956

PCT/NL00/00686

4/6

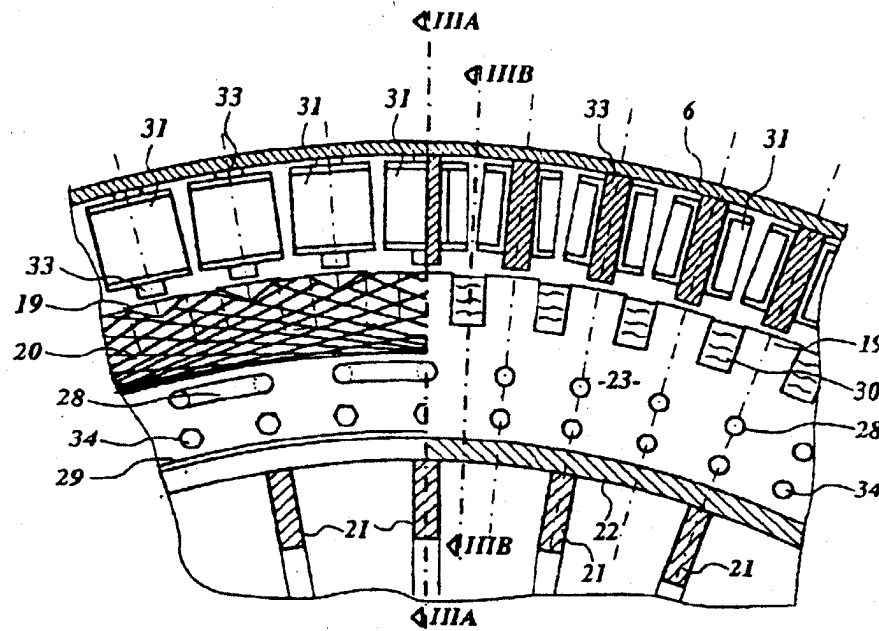


Fig. 4

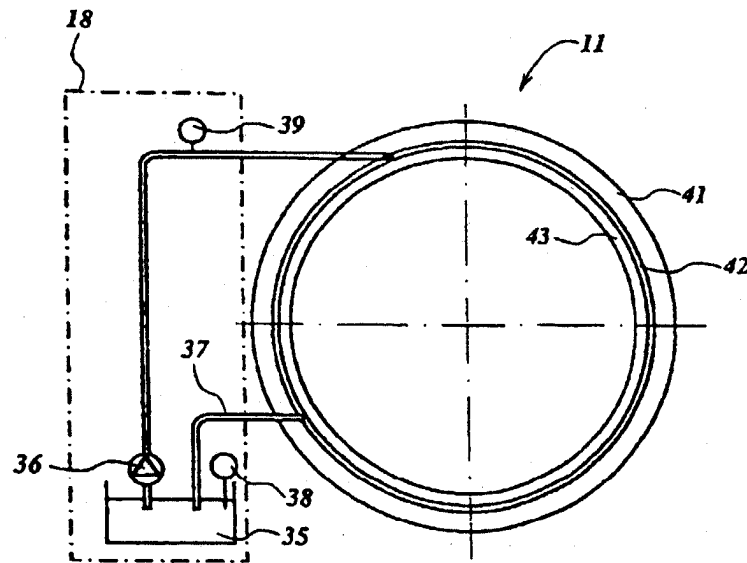


Fig. 5

WO 01/21956

PCT/NL00/00686

5/6

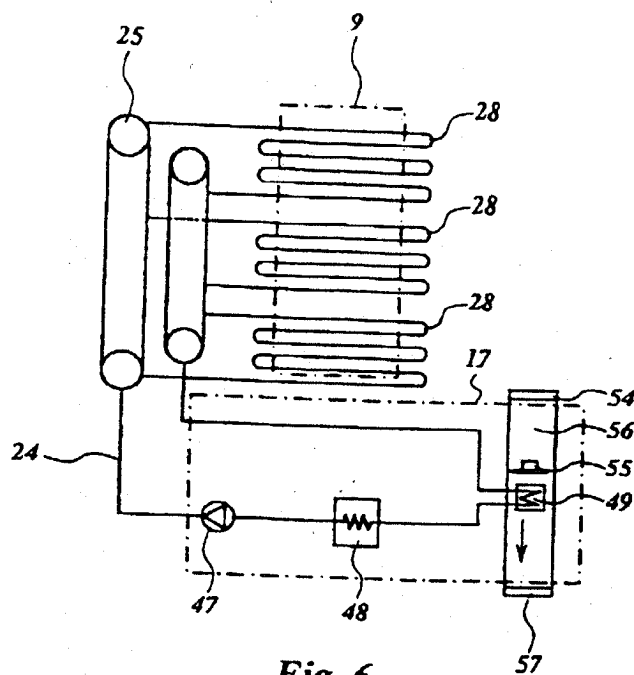


Fig. 6

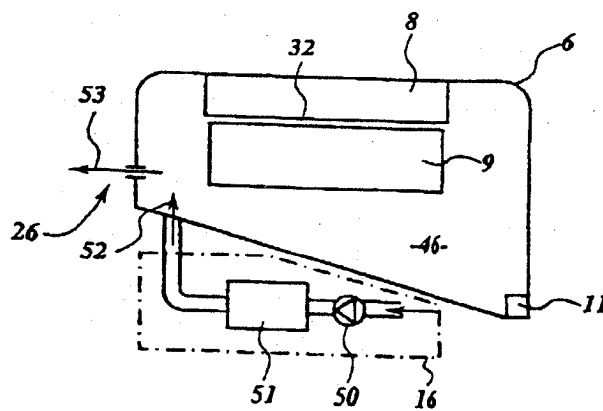


Fig. 7

10/00000001

WO 01/21956

PCT/NL00/00686

6/6

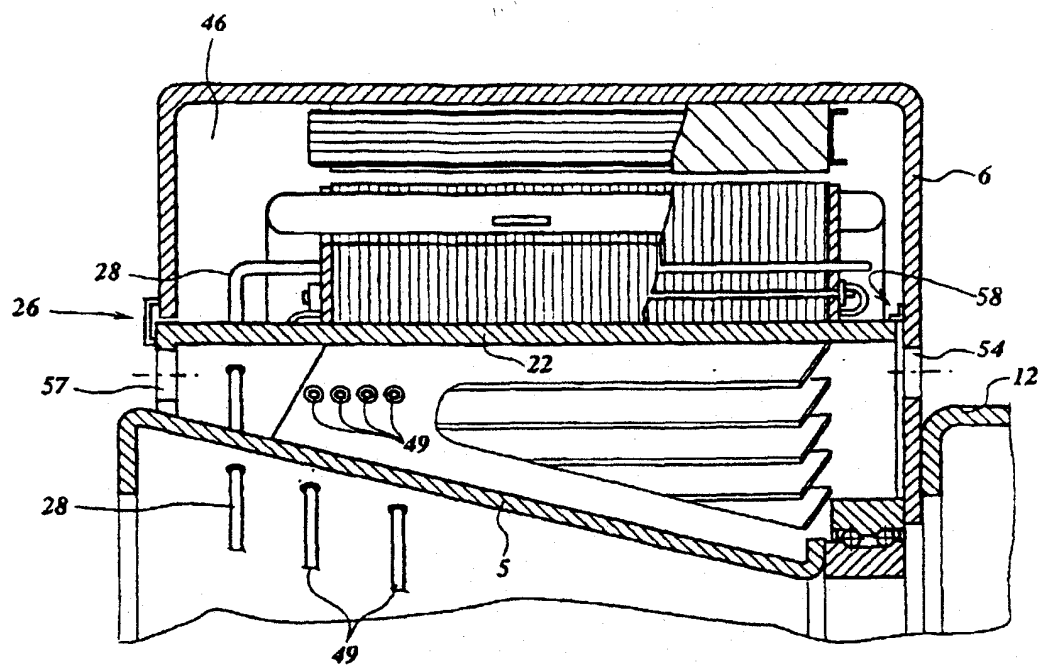


Fig. 8

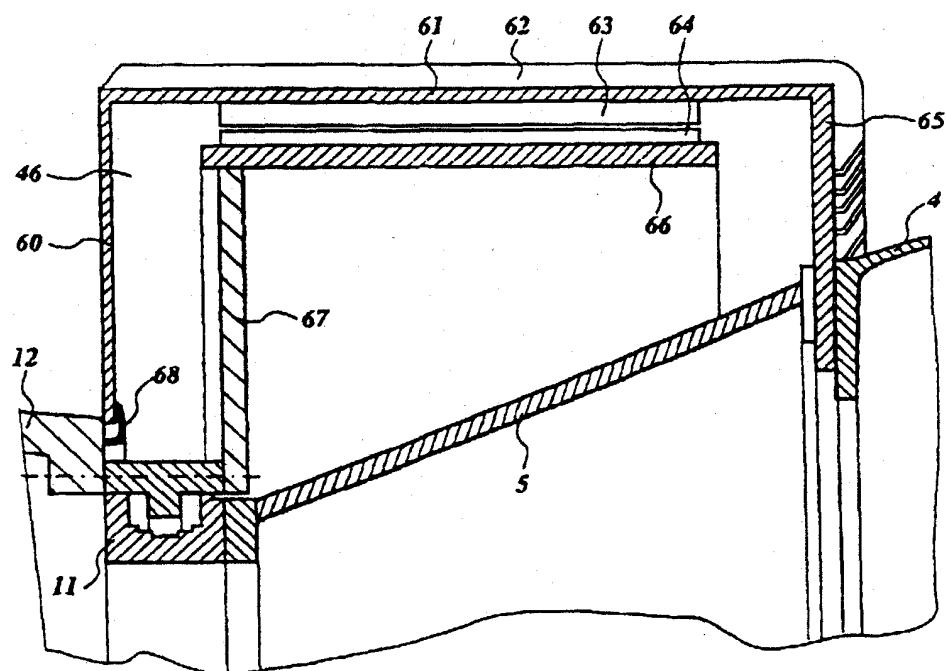


Fig. 9



Creation date: 27-02-2003
Indexing Officer: EGNUYE - ELIZABETH NGUYEN
Team: CENTRALSCANPRINT
Dossier: 10088941

Legal Date: 15-05-2002

No.	Doccode	Number of pages
1	IDS	2
2	FRPR	44

Total number of pages: 46

Remarks:

Order of re-scan issued on